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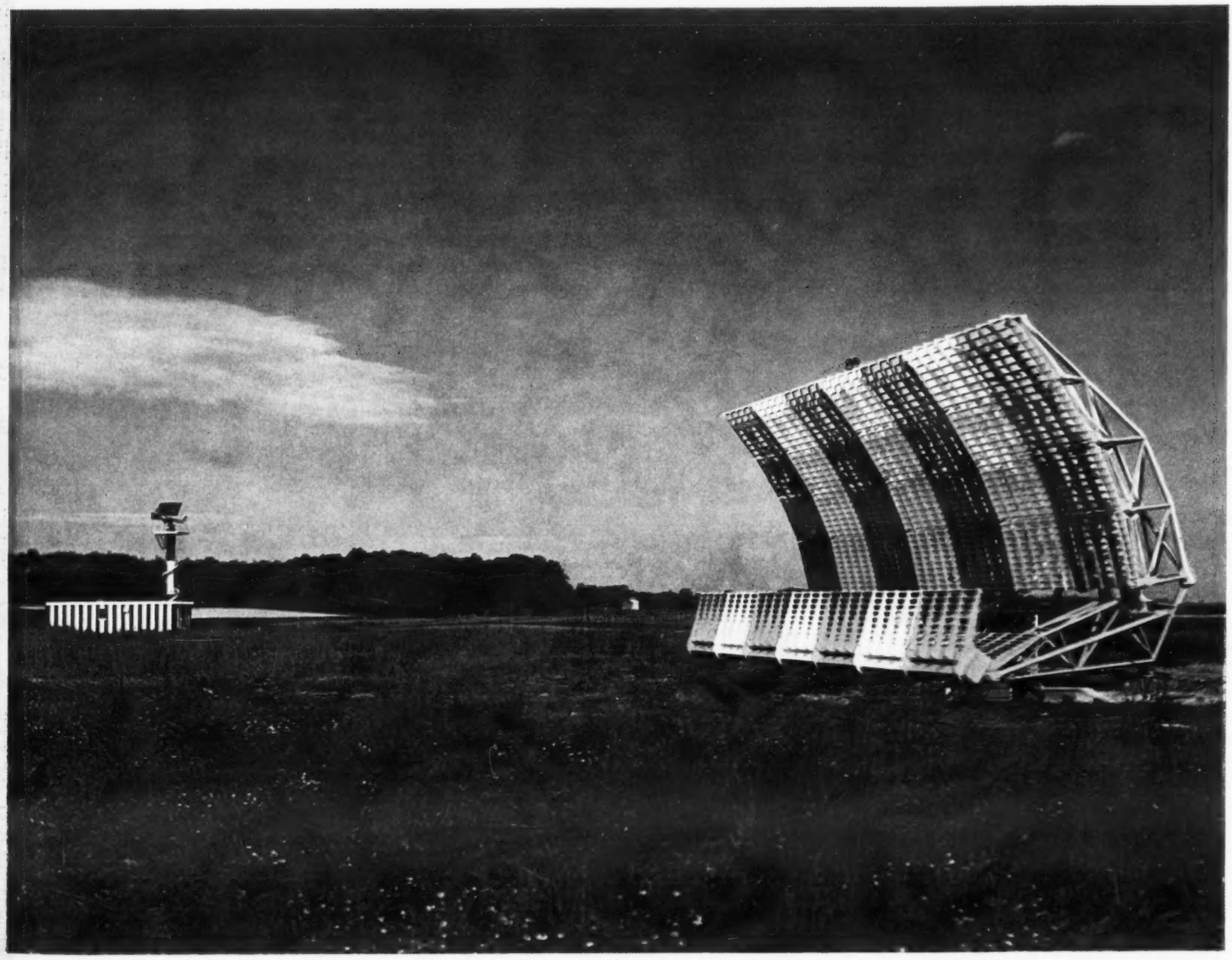

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December 1960

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Front cover : Surveillance radar forms an essential aid to air traffic control. The cover picture shows the Marconi S.264 50-cm equipment (right) and the Thomson-Houston TH.D.1081 10-cm radar at Geneva's Cointrin Airport.

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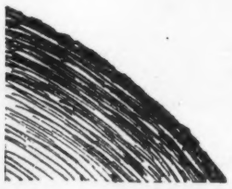

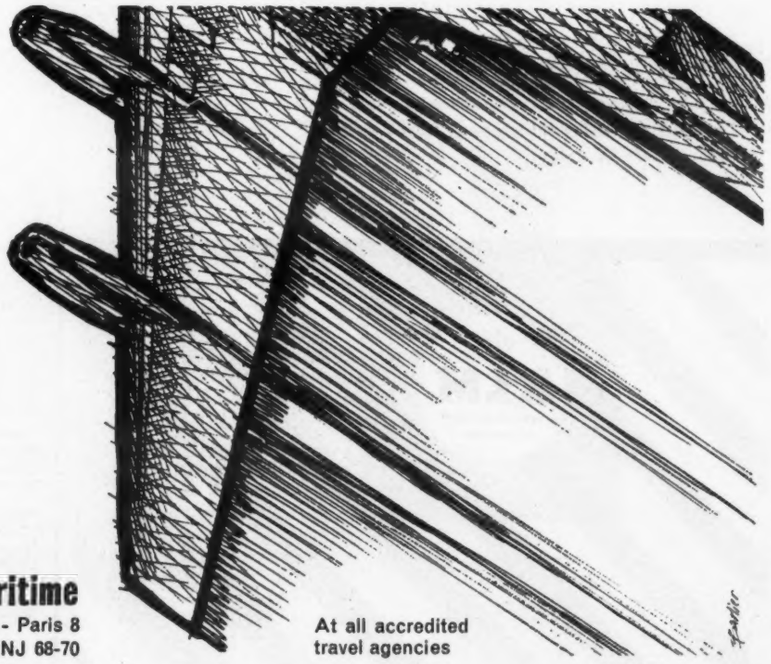

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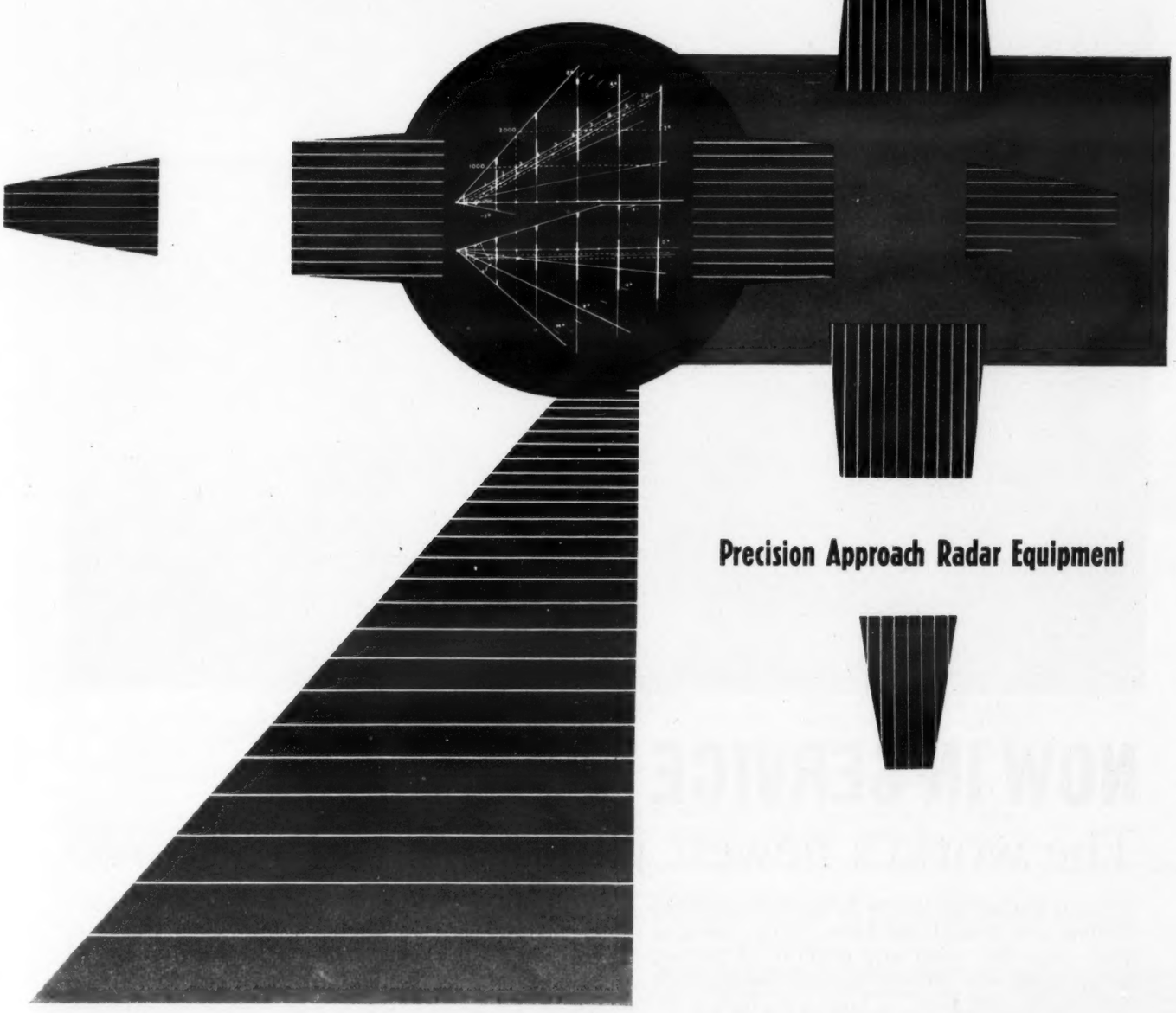

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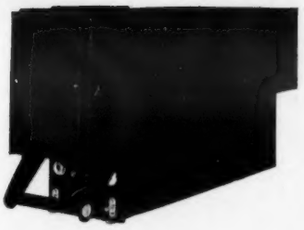

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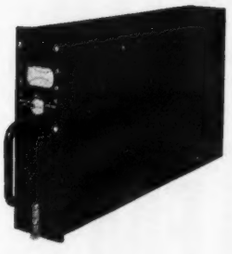

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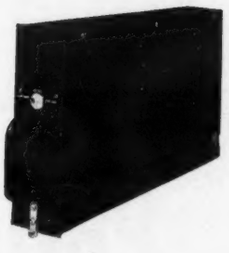

AD 260
V.H.F. Navigation system.
Glide Slope Receiver type
6404 (short ½ ATR. 6 lbs.).

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V.H F. Navigation system.
Marker Receiver type 6403
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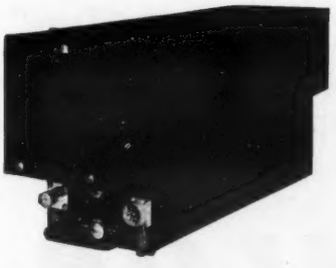

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Receiver type 4486
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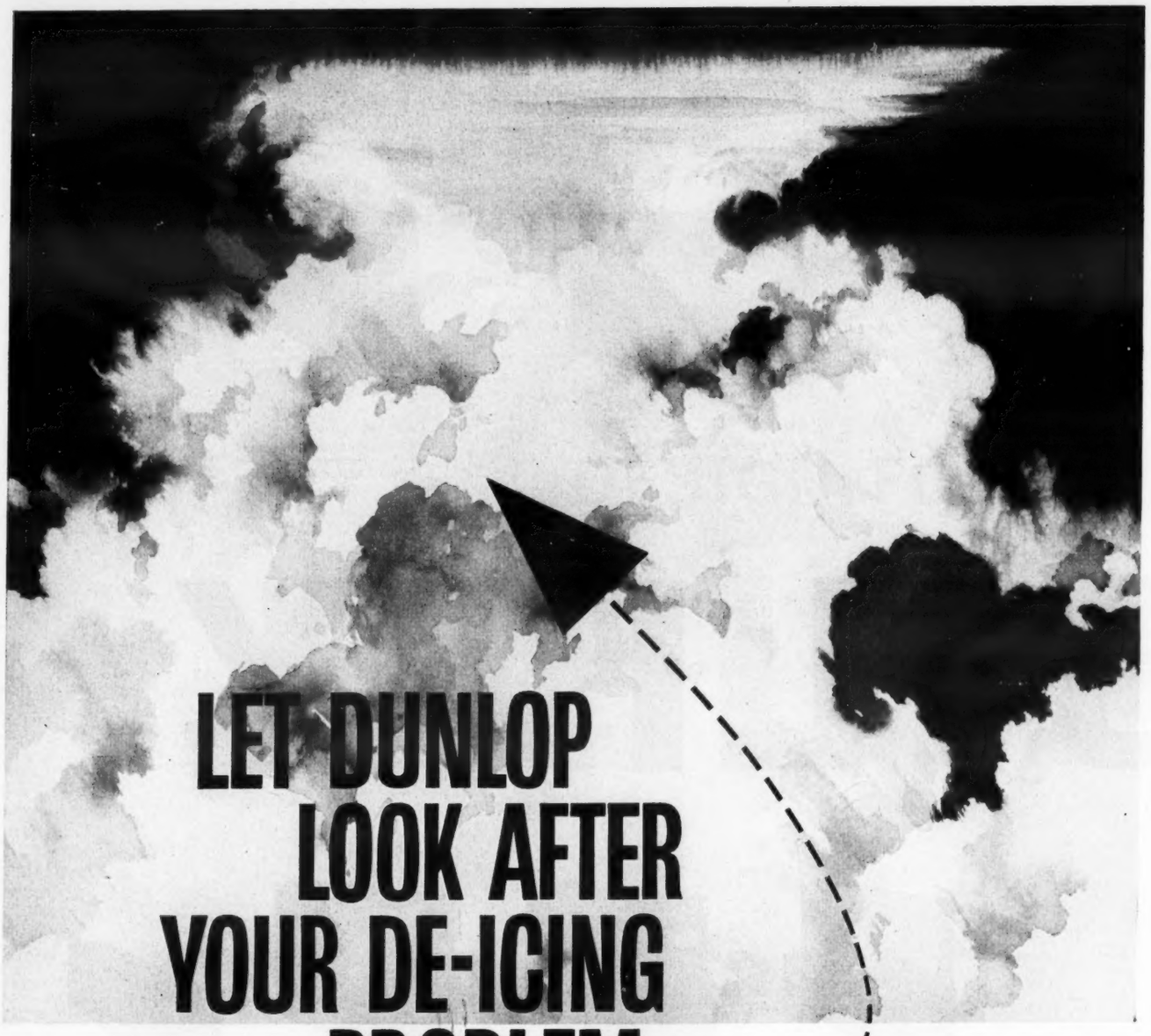

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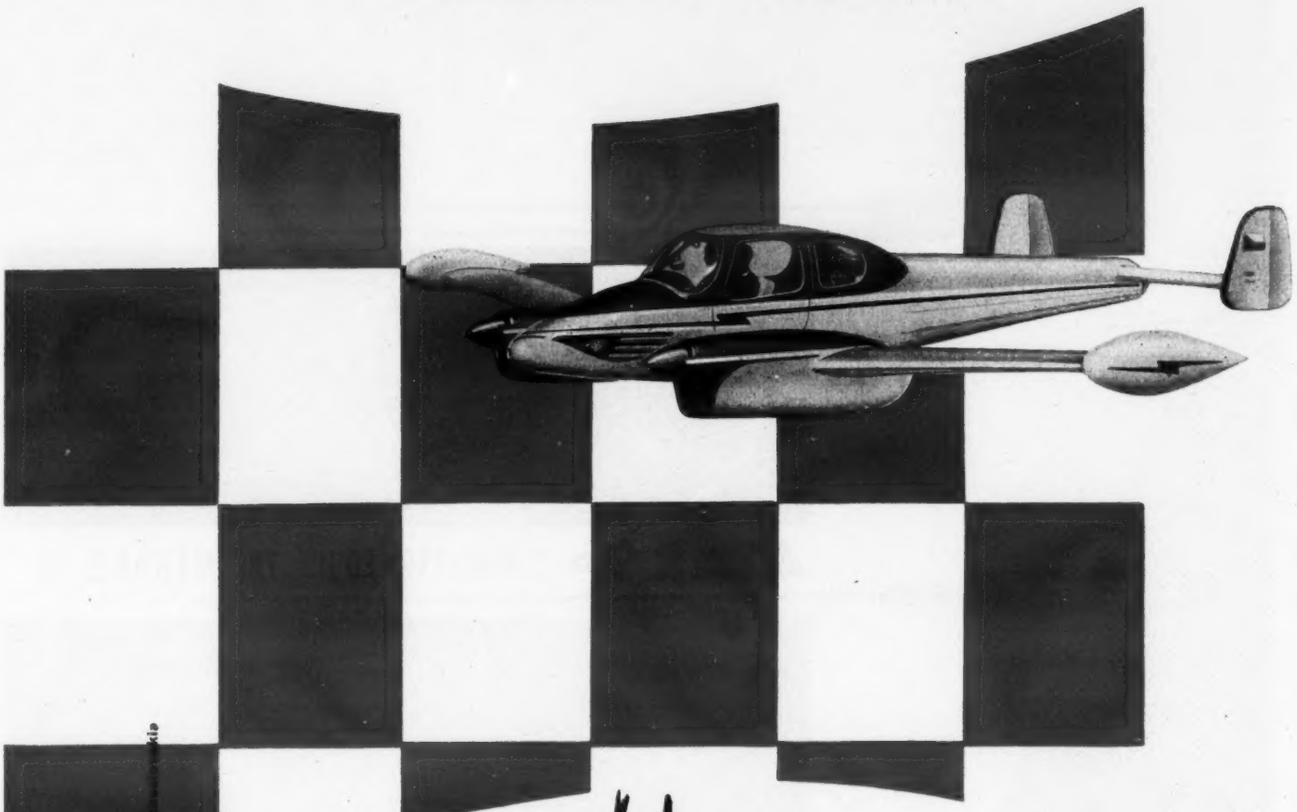

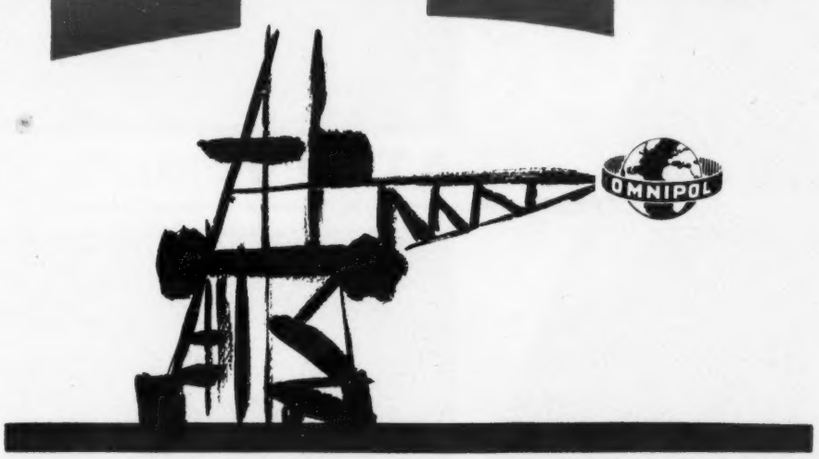

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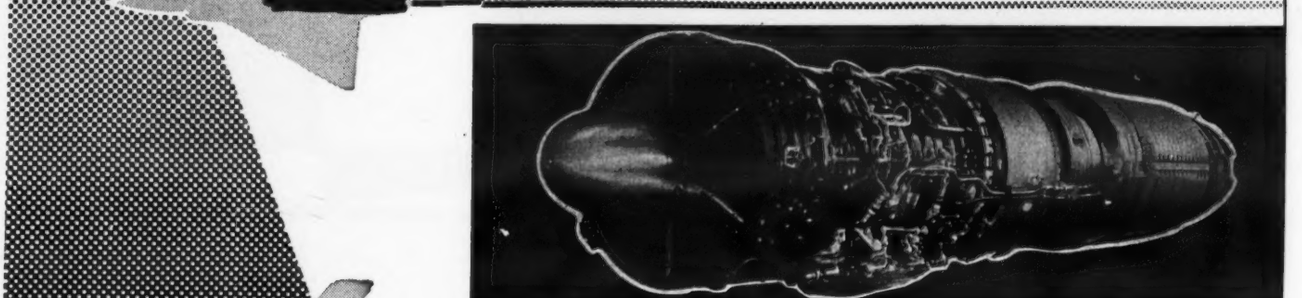

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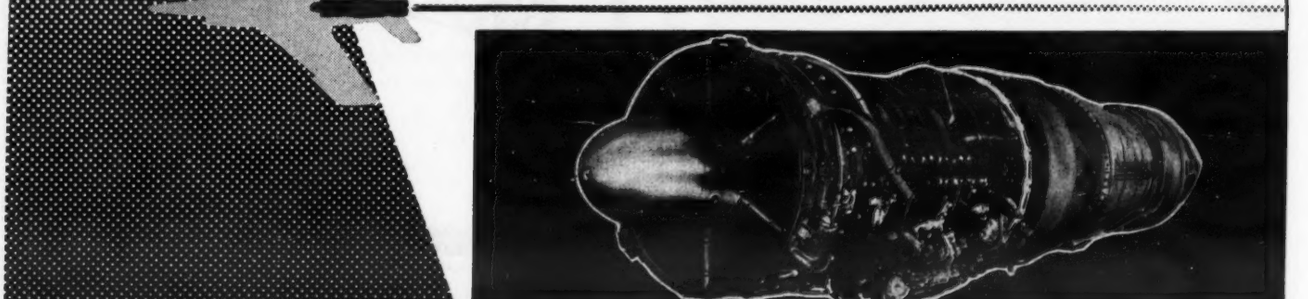

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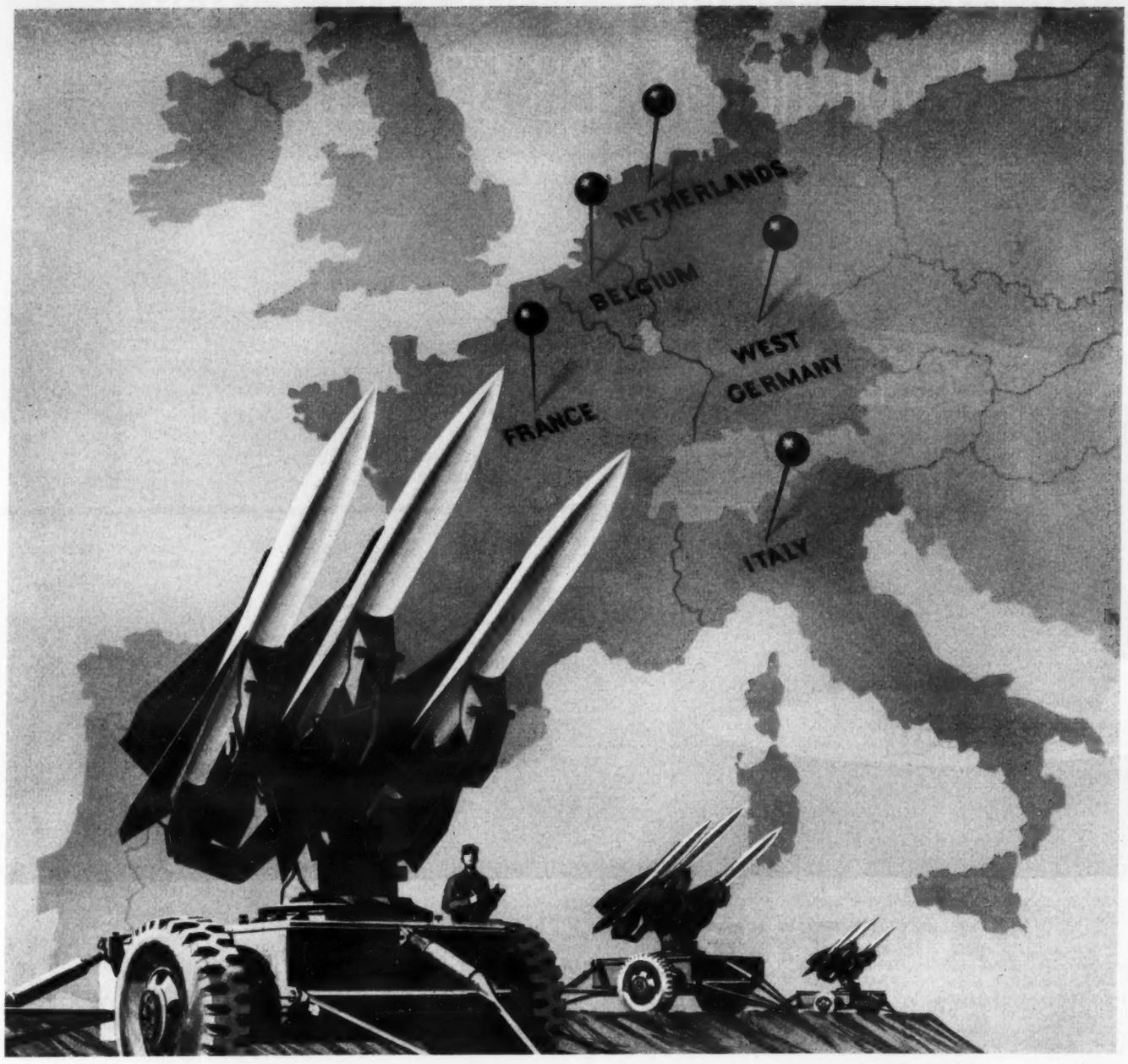

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Raytheon, developer and prime contractor in the U. S. for the Hawk, is supplying technical assistance to the NATO contractors who will manufacture the missile.

The Hawk can be used with fast-moving ground troops or in the defense of fixed installations. It seeks out and destroys supersonic targets at altitudes ranging from treetop to ten miles. Recently the Hawk scored the first interception of a ballistic missile when it demolished an Honest John. Both missiles were traveling at supersonic speeds. The Hawk's success is another example of how Raytheon is contributing, through reliable electronics, to the security of the free world.

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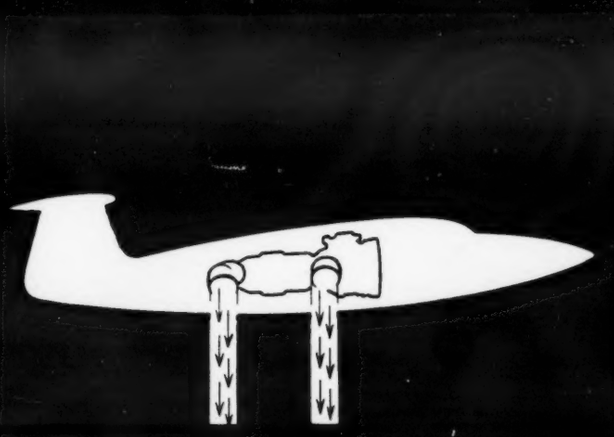

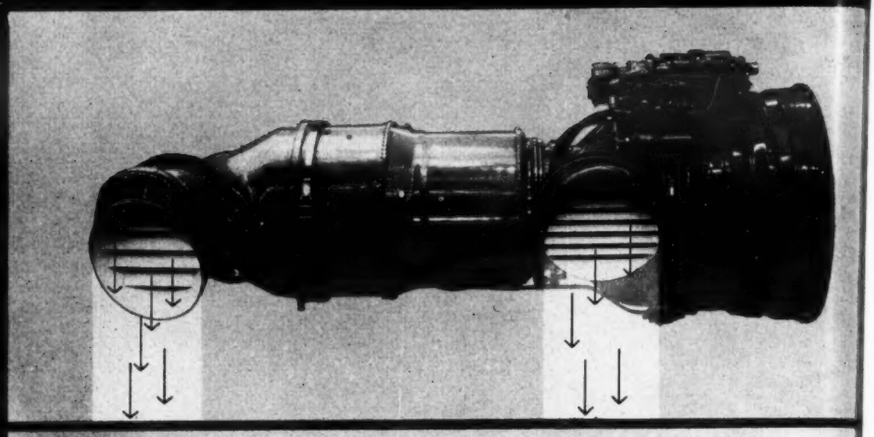

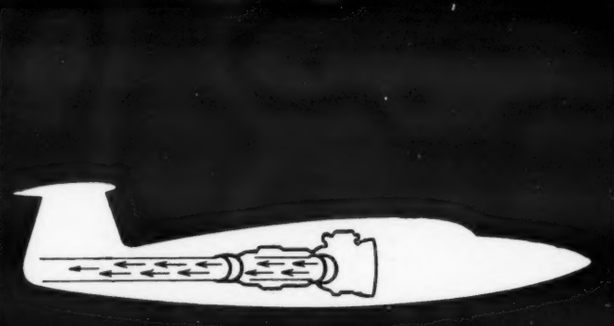

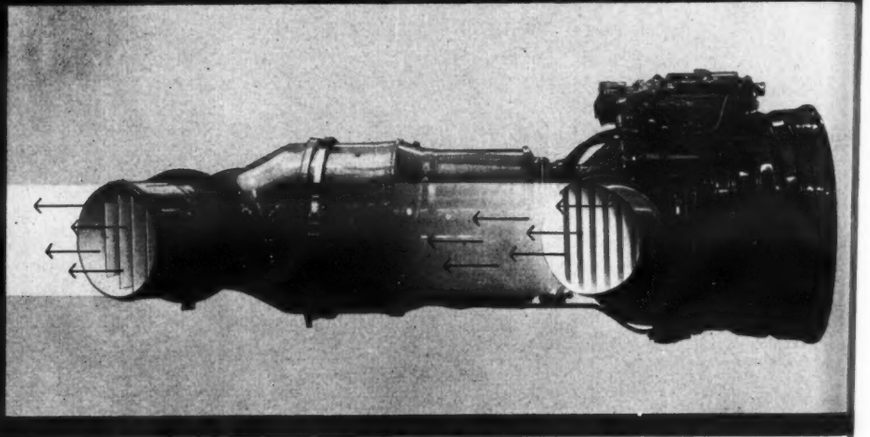

...ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY

The new Bristol Siddeley BS 53 high-ratio turbofan represents a major engineering breakthrough in the field of aircraft propulsion. Because the BS 53 can be fitted with movable nozzles evenly disposed around the centre of gravity which give directional control to its total thrust. this remarkably versatile engine provides the airframe designer with a *single power source for all conditions of flight.*

VTOL, STOL and normal take-off capability in the same aircraft. Suitable for subsonic or supersonic applications.

High cold-flow ratio gives high thrust for low weight, low fuel consumption and low noise level.

Conventional installation. Operational simplicity. Independent of all fixed ground installations.

Problems of ground erosion, recirculation and ingestion of debris reduced to a minimum.

The Bristol Siddeley BS 53 has already been selected for the Hawker P1127 VTOL light strike fighter and is supported by the Mutual Weapons Development Programme for NATO.

BRISTOL SIDDELEY ENGINES LIMITED

INTERAVIA AIR LETTER reports...*

Military Affairs

Recent changes in the U.S. military budget have increased estimated spending for fiscal 1961 from $40,995 million to $41,500 million for the armed forces and from $45,568 million to $45,999 million in all defence spending including foreign aid and atomic energy. The overall increase will bring modifications to the following programmes:

- *B-70*: an increase up to $265 million (see next item for details).
- *Polaris*: an increase of $382 million. A start will be made this year on two more *Polaris* submarines in addition to the three requested by President Eisenhower in January, bringing the total of FBM submarines either built or funded to 14; a $70 million programme to increase the range of the *Polaris* from 1,500 to 2,500 nautical miles.
- *Samos*: an increase from $200 million to $283 million for the *Samos* satellite programme.
- *Aircraft and radar :* an increase of $194 million in funds for purchasing transport aircraft for the Army; an additional $97 million for the purchase of air defence fighter aircraft; a further $82 million for radar warning stations.
- *Army modernization*: an additional $158 million.

●

The Pentagon's B-70 programme for fiscal 1961, funds for which have been boosted by $155 million, covers the construction of one airframe for static tests, one XB-70 for flight tests and two YB-70 prototype bombers. Previously the programme had been limited to two XB-70 flight models without weapons and was supported at a level of $110 million for 1961. The latest boost brings the total funding appropriated for the B-70 since the inception of the programme to $797.3 million.

Top Air Force spokesmen have indicated that the Pentagon action is a stepping-stone towards an eventual production decision. The Air Force would like to have a $1,500 million programme to build nine to twelve B-70 prototypes, but this will depend on budgetary support for the programme in fiscal 1962.

●

The increase in funds for the B-70 has reportedly brought an Air Force decision to end the Convair B-58 *Hustler* programme, with some B-58 funds being switched to the B-70. The curtailment would leave the Air Force with two combat wings of 30 *Hustlers* each, instead of the three wings previously planned. The Pentagon had earlier planned to purchase more than 116 aircraft from Convair, but it now appears that the programme will be closed at 106 aircraft. This will give two wings plus 46 spare and test aircraft.

●

The Belgian Cabinet has now approved a firm order for 100 Lockheed F-104Gs for the Air Force, all to be manufactured in Europe. The Belgian Treasury will finance a batch of 75, and the remaining 25 will be paid for with U.S. military aid funds; these figures are described as final and firm. Preparations for Belgian production of the F-104G are now entering the active phase.

Air Transportation

A report on the feasibility of supersonic transports, prepared for the Federal Aviation Agency by United Research of Cambridge, Mass., concludes that no U.S. manufacturer will undertake the development of a 1,600 m.p.h. civil airliner without Federal assistance, but that U.S. carriers would purchase such an aircraft by 1970, even at a cost of $25 million each. The company considered that work on such an aircraft would cost between $500 and $1,000 million and that the monopoly potential would prevent a joint programme by several manufacturers.

●

Weather problems affecting supersonic transports are to be studied by a special Air Transport Association of America committee, which will investigate conditions in the 60,000 to 80,000 ft levels and recommend meteorological requirements for the supersonic age.

●

Canadian airlines will introduce comprehensive excursion rates on January 2nd, 1961, giving Canada the lowest trans-continental fares offered by scheduled operators anywhere in North America—even undercutting the bargain prices offered by U.S. non-scheduled operators using obsolescent aircraft. The fare for the Montreal-Vancouver round trip will be $182, compared with today's lowest rate of $246. The new rates have been worked out by TCA and agreed by CPAL.

●

Air Express International Corporation will shortly file with CAB new reduced rate tariff proposals applicable to aircraft which this leading freight forwarder is chartering to move cargo shipments to Europe. According to a report from New York, the proposal advocates a system of weight breaks in addition to specific commodity classifications, and is admittedly designed to influence airline cargo rates across the Atlantic. Air Express will attempt to introduce the new rates before the January 23rd meeting of the North Atlantic carriers, who considered but failed to reach agreement on the weight break system during a recent meeting. Air Express current chartering of aircraft is designed to force the issue within the airline industry.

●

British Overseas Airways Corporation will reduce commodity rates between the United Kingdom and Montreal by up to 8 pence per kilogramme on January 1st, 1961, to bring them level with the current rates to New York. A new basic rate for general cargo between the United Kingdom and Melbourne will be introduced on April 1st, 1961; this will be fixed at £2 4s. per kg up to 45 kg, and £1 13s. per kg above 45 kg.

●

Swissair and Misrair have signed a pool agreement covering freight and passenger traffic between Switzerland and Cairo; the agreement covers only through traffic between the two countries and not sectors of the route.

●

Italy and Australia have signed a commercial air agreement covering scheduled operations between the two countries. Qantas gets permanent transit rights in Italy, while Alitalia gets permission to operate a regular service to Australia. Under present planning, the latter will be inaugurated with DC-8s in the spring of 1961.

●

Ethiopian Airlines inaugurated once-weekly round-trip DC-6B scheduled service on the Addis Ababa-Khartoum-Accra-Monrovia route on November 8th. Technical stops are made in each direction at Lagos, Nigeria, and traffic rights are under discussion between the Nigerian and Ethiopian Governments. Ethiopian Airlines is also discussing a possible extension of the service to Conakry with the Guinea Government. The DC-6Bs will be replaced by Boeing 720Bs in December 1961.

●

Zonta International, the Service Organization of Business and Professional Women Executives, is offering grants of $2,500 to suitably qualified women wishing to study advanced aeronautics during the 1961-62 school year. These scholarships are awarded annually in memory of pioneer airwoman Amelia Earhart. Applications should be made *not later than February 15th, 1961*, to Dr. Helen Pearce, 490 Oak Street, S.E., Salem, Oregon.

●

Rome's Fiumicino Airport—contrary to earlier reports—was not handed over for scheduled operation by IATA airlines on November

The E. E. Heiman Prize

Reminder to intending participants

To avoid the disappointment arising during the first Interavia Essay Competition, the Competition Secretariat urges intending participants not to postpone sending in their essays until the last moment. December 31st is a legal holiday in Geneva, and there is no guarantee that mail arriving in the city on that day will in fact be delivered before noon.

Once again a number of handwritten manuscripts have been received. The Committee would therefore call the attention of participants to Article 3 of the Competition Rules (published in *INTERAVIA* for June and October, 1960), which expressly states that essays should be submitted in duplicate and in typescript.

INTERAVIA S.A., Geneva

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1st, and it now appears that Ciampino will continue to be used for scheduled services until some time in the New Year.

Industry

Canada's Air Industries and Transport Association, at its 26th Annual Meeting, warned the Federal Government that recognition of the industry's needs is imperative. Fred T. Wood, the Association's President, said in his report that the industry's gross sales in 1959 totalled $462 million, down $135 million on the 1958 figure. Employment during the year fell to 28,516, a drop of 1,500 including over 700 engineers and scientific personnel who moved to the United States.

Industry spokesmen presented the following recommendations to the AITA Directors:

- The Government should seek the advice of the Air Transport Board and the industry to institute a "sound overall Canadian air transport policy."
- The Minister for Air should be a member of the Cabinet.
- The Royal Commission on the organization of Federal Government should investigate whether civil air operations currently handled by the RCAF and other Canadian and foreign government agencies could not be handed over to commercial carriers.
- Means should be sought to re-establish the industry on a profitable basis with financing arranged and private investment encouraged.
- AITA should make every effort to ensure that new jet transports for Canadian carriers are manufactured in Canada.
- The armed services should be encouraged to make known their long-term requirements for the manufacturing, repair and overhaul industries.

●

Employment in California's defence industry has continued to climb despite a decline of 50,000 in aircraft and airframe employment since October 1959. Electronics firms, currently employing 160,000, and ordnance firms with 70,000 workers, have raised the total defence industry employment to 420,000, according to figures published by the Californian Department of Industrial Relations.

●

A western European space research centre is to be established at Queen's University, Belfast, Northern Ireland, as a joint enterprise with the U.S. Advanced Research Projects Agency. The University will receive the largest financial award ever made by the U.S. Government for work in this field in western Europe, including a $150,000 electronic digital computer and funds for additional research staff appointments. A special building will be erected for the computer, and a new lectureship in digital computing established. Main work will be to extend current research on the properties of atoms and molecules affecting missile flight and conditions in space. First year spending will be approximately $200,000 and will continue at the rate of $56,000 a year.

●

Republic Aviation and Fokker representatives are to meet in Amsterdam in early December to initiate a new joint VTOL fighter-bomber project to meet NATO requirements. Last March, Republic and Fokker signed a far-reaching agreement for cooperation in the field of aircraft and missile production, with Republic acquiring a one-third holding in the Fokker capital. The two companies are also collaborating on a STOL transport project aimed at both civil and military markets.

Republic has been engaged for the past five years on a $5 million research programme in the V/STOL field and has projected a new supersonic STOL variable-sweep all-weather fighter-bomber to meet U.S. Tactical Air Command requirements.

Republic is now completing plans with Fokker for the establishment of a European inspection, repair and overhaul centre to support the F-105D *Thunderchief* which will shortly be deployed in large numbers with USAF units in Europe.

●

Boeing Airplane Company plans a major drive to expand its overseas business. Senior Vice President Wellwood E. Beall, who made a five-week tour of Europe this autumn, has listed a four-point programme: 1) establishment of Boeing International regional offices in Paris and Tokyo; 2) broadening the scope of overseas sales activities in the commercial and military fields; 3) development of new products for overseas markets, including NATO; 4) investigation of foreign products to be manufactured in the United States.

The company is considering, for example, overseas production of its 502/520 series of light gas turbine engines in both Japan and Europe. The European operation would be covered by a licensing agreement or the formation of a joint company with a European firm. Boeing is also negotiating an agreement with a French company for the exchange of non-classified information.

●

A syndicate headed by Kawasaki Dockyard Co. has been formed to begin talks on a technical agreement with Boeing Airplane Co. for production of the *Bomarc* missile in Japan. Representatives of Kawasaki Dockyard, Kawasaki Aircraft, Fuji Electric and Nissho Trading Co. have met in Tokyo to consider details of the approach to be made to Boeing.

●

Sumitomo Precision Industry Company is the name of a new company to be formed in January 1961 out of Sumitomo Metal Industries Co.'s Propeller and Components Division.

●

Rolls-Royce de España S.A. is a new Rolls-Royce associate company which has been set up in Barcelona to develop the manufacture and sale of the British company's products in Spain.

Missiles and spacecraft

Soviet scientists plan to launch a chain of meteorological satellites into polar orbits. Equipment would include television cameras for the continuous transmission of cloud pictures and instruments to measure radiation intensity at high altitudes. Small vernier rockets would be used to correct trajectory.

●

A Discoverer instrument capsule was recovered in flight by a Fairchild C-119 crew for the second time on November 14th. The satellite, *Discoverer XVII*, was launched from Vandenberg AFB, California, on November 12th, by means of a *Thor-Agena B*, went into orbit and on completion of the thirty-first orbit received a radio signal from the ground which separated the instrument capsule and started it back to earth. In previous tests the capsule had been programmed to separate automatically during the seventeenth orbit.

Discoverer XVII had an orbital period of 96 minutes 45 seconds, a perigee of 117 miles and an apogee of 615 miles.

●

The Explorer VIII research satellite was successfully launched from Cape Canaveral on November 3rd, 1960, by a four-stage *Juno II*. The aluminium satellite, shaped like two buckets joined at the rims, has a diameter and height of 30 in. and weighs 90 lb. It is instrumented for ionospheric research under NASA project S-30; its tasks include measurement of electron density, the density and pattern of ions at the upper limits of the atmosphere, recording and determining the force of micrometeorite impacts. Data are transmitted on the 108 and 138 Mc/s frequencies.

●

A new aerospace chamber, designed to simulate environment and temperature encountered by orbital vehicles, is to be installed at Lockheed's new Rye Canyon Research Center, near Saugus, California. The chamber will measure 10 feet in height and 10 feet in diameter and will simulate altitudes of up to 800,000 ft and temperatures down to −320°F. Eventually, five test chambers, of different sizes and for different series of tests, will be used at Rye Canyon. All will have been installed by the end of 1961 and be operating early in 1962.

First flights and new aircraft

A North American X-15 rocket research aircraft, for the first time fitted with the new, higher-powered Thiokol-Reaction Motors XLR-99-RM-1 engine, began flight testing on November 15th, 1960. During the flight, Test Pilot Scott Crossfield reached a maximum speed of about 2,000 m.p.h. and a maximum altitude of about 80,000 ft. The engine was not operated at peak power. The XLR-99-RM-1, also known as *Pioneer*, is a controllable-thrust engine, with the following characteristics: thrust 58,700 lb, specific impulse 284 sec, combustion chamber pressure at full thrust 600 p.s.i., dry weight 910 lb, diameter 40 in., length 72 in.

●

The military version of the Max Holste Super Broussard transport has just been shown for the first time, in mockup form, to a small group of representatives of the trade press. Unlike the civil version, the military *Super Broussard* has a fully transparent nose, with observer's and gunner's positions, and a tail loading ramp. Among the equipment which it can transport are two batteries of guided anti-tank missiles mounted on jeeps. Nord-Aviation, which is responsible for two-thirds of the work on the civil *Super Broussard* and for its final assembly, has begun work on a pre-production batch of ten aircraft.

●

The Procaer F.400 Cobra lightweight business aircraft (one Turboméca *Marboré II* jet engine of 880 lb thrust), designed and built by Progetti Costruzioni Aeronautiche, has begun flight testing at Milan-Malpensa Airport.

●

A number of Ilyushin Il-28 light twin-jet bombers have been converted for meteorological purposes. According to Tass reports from Moscow, the aircraft are to be used mainly for the civil weather service. The Il-28 (NATO code name *Beagle*) is powered by two VK-1 engines (6,000 lb thrust each) and has a normal fuel capacity of 2,640 Imp. gal., with additional capacity in the wing-tip tanks. It normally operates at altitudes of around 40,000 ft; range of the bomber version is about 1,350 nautical miles with full bomb load, but the meteorological version with additional fuel is expected to have at least double this range.

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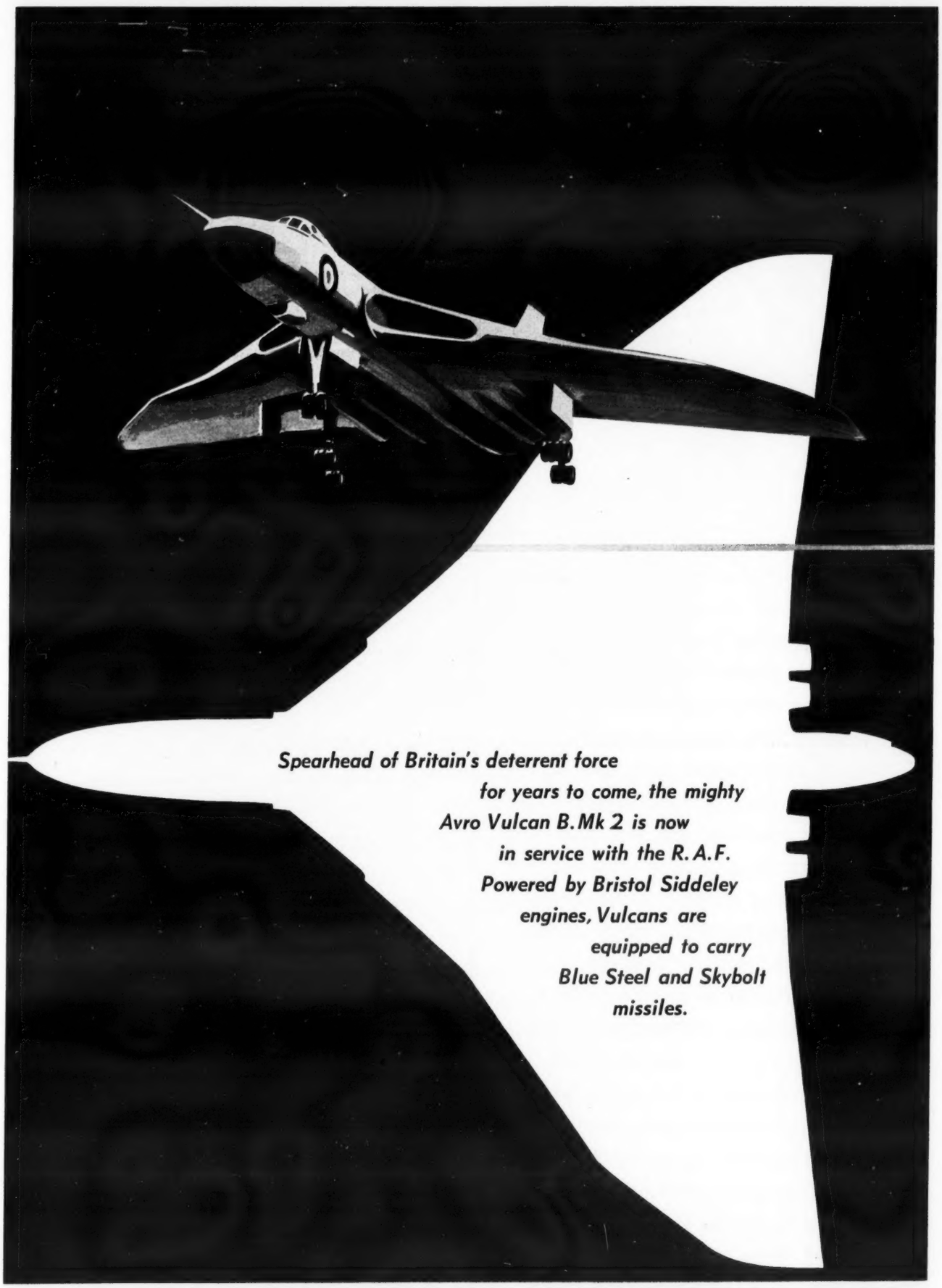
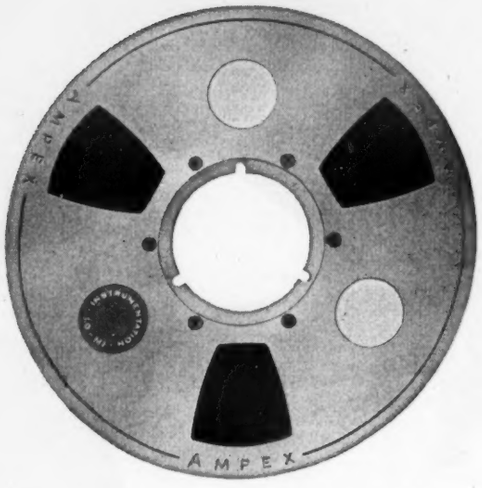


Spearhead of Britain's deterrent force for years to come, the mighty Avro Vulcan B.Mk 2 is now in service with the R.A.F. Powered by Bristol Siddeley engines, Vulcans are equipped to carry Blue Steel and Skybolt missiles.

HAWKER SIDDELEY AVIATION *32, Duke Street, St. James's, London, S.W.1*



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INTERAVIA Air Letter Reports...

(contd. from page 1464)

Aircraft and Powerplants

Avian Industries Ltd., of Georgetown, Ontario, is conducting static tests on its two-seat autogyro, the Model 2/180, and hopes to start the flight test programme by early 1961. The Avian 2/180 is powered by a 180 h.p. Lycoming engine and is expected to cost $10,000.

●

Pratt & Whitney announces a new gas turbine engine, the JFTD-12, for use in aircraft as well as ground and marine vehicles. First installation of the new JFTD-12 will be in the large twin-engine Sikorsky S-64 *Skycrane* helicopter ; in this application the JFTD-12 will develop 4,050 s.h.p. An industrial version, known as the FT-12, will have a maximum rating of 3,000 s.h.p.

●

The Blackburn SP.62 flying crane, on which design work is continuing, will reportedly be capable of lifting about 50 tons ; it will be powered by six Bristol Siddeley shaft turbines. All three armed services in Britain, as well as haulage contractors and airlines, are showing interest in the SP.62.

●

The first prototype of the Potez 840 short-haul airliner (four Turboméca *Astazou* propeller turbines) is nearing completion at the Potez Argenteuil facility. The first flight is scheduled to take place in February next year. A second prototype, carrying a storm warning radar in its nose, should be ready for flight testing before the Paris Air Show (May 26th to June 4th, 1961). Two further prototypes are also to be built ; one will serve for static load tests, while in the second the *Astazous* will probably be replaced by other engines of a type as yet unspecified.

●

Del Mar Engineering Laboratories and Summers Gyroscope Co. have announced plans to adapt the Summers autopilot and command guidance system for remote drone control of the pilotless Del Mar *Whirlymite* helicopter. The helicopter, now testing, weighs only 300 lb and can attain altitudes of up to 10,000 ft. A one-man piloted version also exists.

Accessories and Equipment

General Acoustics Corp. has introduced on the market a new series of portable jet run-up noise suppression systems. These consist of noise control units for jet engine intake and exhaust, and reduce noise levels by 10 to 25 decibels at distances of 250 ft. GAC study projects also involve high-intensity noise produced during missile and space vehicle launchings from surface and silo-type facilities.

●

Fairey Engineering Ltd. has concluded an agreement with Del Mar Engineering Laboratories for the sale of Del Mar high-performance target systems for training crews in the handling of air-to-air and surface-to-air missiles. The agreement covers sales rights in the United Kingdom, the Middle East (excluding Israel), South Africa and Australia. It also covers the Continental European market with the exception of Germany, Switzerland and Scandinavia.

The heart of the Del Mar system consists of a lightweight target which can be towed at subsonic or supersonic speeds. It can be equipped with flares to attract missiles with infra-red homing heads, or with special devices to enable the pilot to detect the target visually over long ranges.

●

Carl Zeiss has brought onto the market a Mach-Zehnder interferometer to measure variations in density in transparent media. Some typical applications are the measurement of flow processes, particularly in wind tunnels and shock tubes, the measurement of sonic phenomena in liquids and gases and of temperature distribution in the vicinity of heated bodies, flame measurements etc.

●

The U.S. Army Signal Corps has developed a new type of silicon solar cell, which is claimed to be at least ten times more resistant to high-energy radiation than current cells. NASA hopes to place the cells experimentally in satellites within the next six to eight months.

The AMPEX CP-100 is a compact, extended-frequency instrumentation tape recorder/reproducer. Tape transport, motor drive amplifier, heads, power converter, controls and all-transistorized plug-in record/reproduce electronics are contained in a single 13¼" x 19" x 33¼" mobile case. The CP-100 operates on 28-volt DC, with 48 to 400 cycle converters available for other power sources. Data is recorded by direct or FM carrier techniques on up to 14 analogue tracks. The CP-100 offers frequency response to 200 Kc at 60 ips or expanded recording time of 24 minutes for 100 Kc data at 30 ips on a standard 10½" reel. Transport tape speeds – 1⅞, 3¾, 7½, 15, 30 and 60 ips – and plug in frequency determining units and equalizers associated with tape speeds, may be quickly changed. The versatile and mobile CP-100 performs reliably over a temperature range of from −50° F to +160° F, up to an altitude of 10,000 feet, in relative humidities to 95%... and is designed to withstand shocks and vibrations encountered in rugged mobile testing applications. This recorder may also be rack mounted if desired. For complete details write Ampex Great Britain Limited, Arkwright Road, Reading, Berkshire, England. AMPEX

EVEN BETTER THAN PROMISED

Before the first Vanguard goes into scheduled service, and little more than a year after the first flight tests, development has made possible dramatic increases in maximum operating weights. Details are given in the table below. These improvements have been achieved for an empty weight increase of only 600 lb, and allow a margin of 1,600 lb for future development, equipment changes or customers' special requirements.

VANGUARD PAYLOAD UP BY 8,000 lb

	Original specification	New specification	Increase
GROSS TAKE-OFF WEIGHT	141,000 lb	146,500 lb	**5,500 lb**
MAX. LANDING WEIGHT	121,000 lb	130,500 lb	**9,500 lb**
MAX. 'ZERO FUEL' WEIGHT	112,500 lb	122,500 lb	**10,000 lb**
MAX. PAYLOAD	29,000 lb	37,000 lb	**8,000 lb**

The Vanguard can now carry 139 economy-class passengers plus over 8,000 lb freight. Without intermediate refuelling, 100-passenger payloads can be carried over such important consecutive sectors as London–Frankfurt–Vienna–Prague.

Operators with profit in mind and air travel for all in view, will find the Vanguard is more attractive than ever.

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The airliner with the biggest profit potential ever offered to the operator

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

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TGA AT655

RADAR

50 cm Gives longer range for given transmitter power.
The Marconi series of 50 cm radars gives clearance of jet aircraft from take-off to 150 miles plus on a power of only 500-600 kW. The one radar meets both airways surveillance and air traffic control requirements. Running costs are thus much lower.

50 cm Penetrates thick weather without loss of efficiency.
In most radars precipitation clutter seriously obscures the PPI picture. No remedial device is 100% efficient. The choice of the 50 cm wave length, however, avoids the difficulty entirely. It gives a clear picture of aircraft, even in heavy rain or snow, and also indicates the position of storm centres.

50 cm Permits M.T.I. elimination of permanent 'clutter'.
Of the various ways of clearing the echoes of stationary objects which confuse the interpretation of the radar situation, M.T.I. (moving target indication) undoubtedly gives the best results. The use of 50 cm makes it possible to use crystal control throughout a radar system to which a simple and completely stable M.T.I. can be harnessed to give a clear and unambiguous picture.

50 cm Switches into instant operation.
Crystal control of frequency enables Marconi 50 cm radar to be brought into instant operation even after long periods of inactivity.

GIVES THE LONG, CLEAR VIEW

MARCONI

COMPLETE CIVIL, MILITARY AND NAVAL RADAR SYSTEMS

SURVEYED, PLANNED, INSTALLED, MAINTAINED

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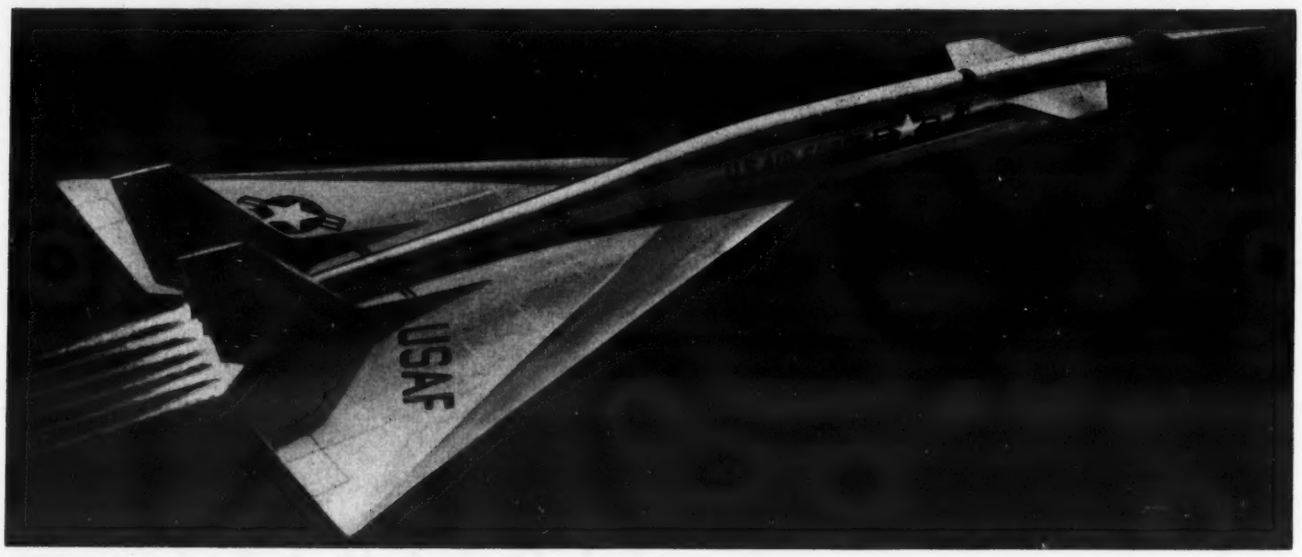
INFERNO...CONTROLLED

B-70's high speeds and tremendous cooling loads pose the most demanding environment control problems ever encountered



At 2,000 mph, skin temperatures of the USAF/North American B-70 will soar as high as 600°F. Yet the crew and avionic gear will function in ideal temperatures—from sea level to 70,000 feet.

To solve the plane's extraordinary operational requirements, Hamilton Standard is developing the most advanced and comprehensive environment conditioning system ever planned for an aircraft. It will provide completely automatic...

- cooling and pressurization of avionic gear and crew compartments
- emergency ram-air cooling and pressurization
- temperature control for drag-chute and landing-gear compartments
- moisture removal
- air-contaminant control

MAIN COOLING for crew and avionic compartments is provided by a closed vapor-cycle/air recirculation system and several closed-loop transport systems.

THE B-70 PROGRAM is an excellent example of Hamilton Standard's unmatched systems capability in environment conditioning and control. It incorporates skills and experience the company has amassed in creating systems for such advanced aircraft as the F-104, F-105, B-58, 880 Jet-Liner and over 40 other leading military and commercial planes.

HAMILTON STANDARD TODAY is a leading designer and manufacturer of aerospace equipment. Among current products at Hamilton Standard are advanced aircraft propellers, electronic equipment, engine and flight controls, and ground support equipment.

FURTHER INFORMATION on current Hamilton Standard programs and services is available. Your inquiry is invited.

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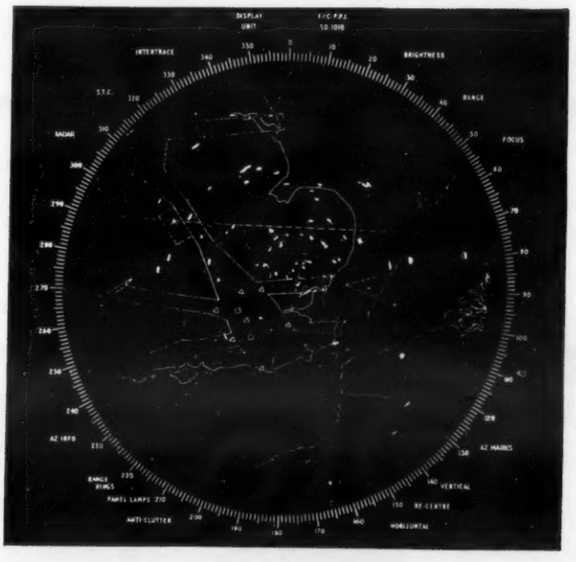
Marconi 50 cm. Radar is immune from weather effects without polarisers and has a fully coherent crystal controlled MTI system.

30 MARCONI *50* CM. RADARS HAVE BEEN ORDERED OR INSTALLED IN THE U.K., EUROPE, ASIA, AFRICA AND AUSTRALASIA.



MARCONI

COMPLETE CIVIL, MILITARY AND NAVAL RADAR INSTALLATIONS

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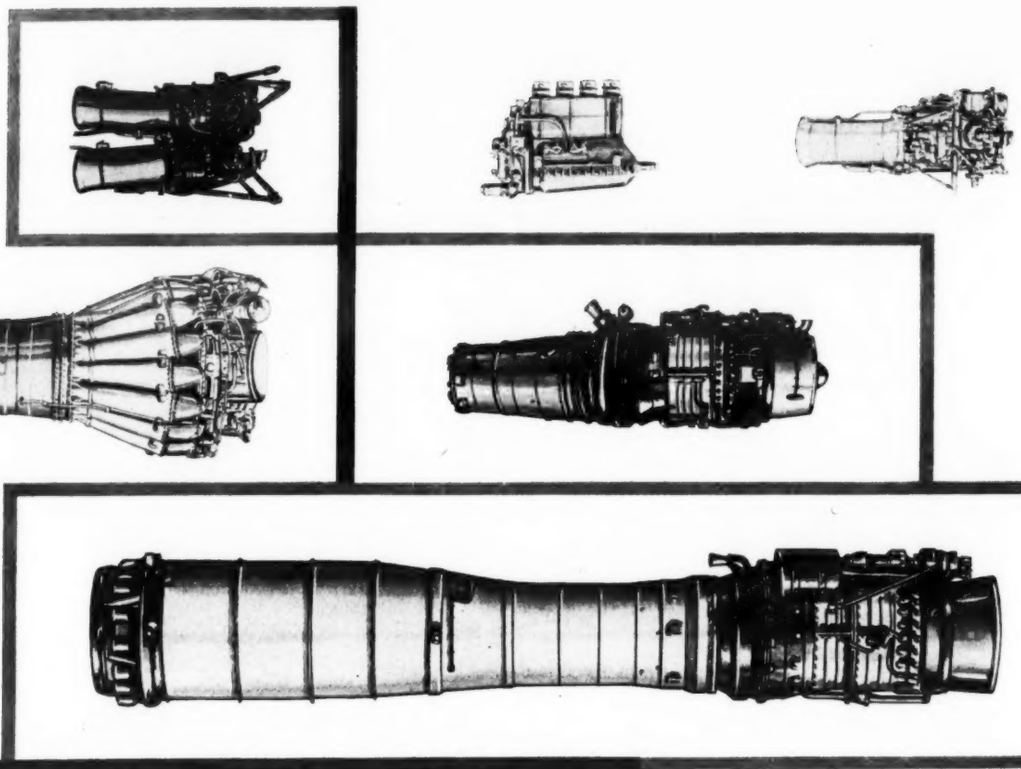
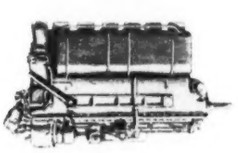
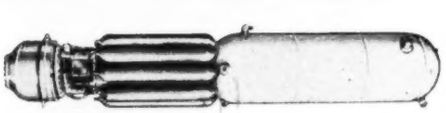
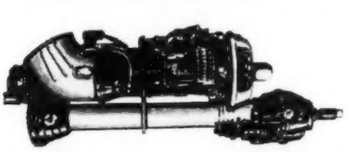


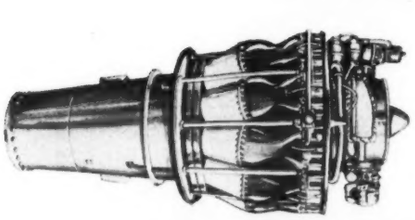
DE HAVILLAND ENGINES

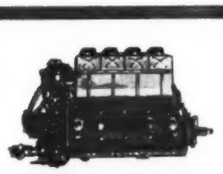
The de Havilland Engine Company has in production turbojet, turboshaft, piston and rocket engines for a wide variety of applications ranging from helicopters to high supersonic aircraft.

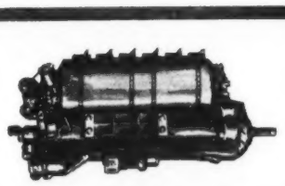


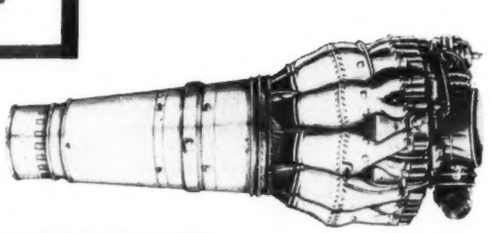


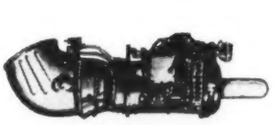












THE DE HAVILLAND ENGINE COMPANY LIMITED, LEAVESDEN, HERTS

Member Company of the Hawker Siddeley Group

The Jet Age and the Balance Sheets

BY SCOTT HERSHEY, NEW YORK

The gay music which heralded the advent of the jet age has pretty much died down, and while the melody lingers on there are sounds of discords in some quarters, and in still others some of the guests who danced at the party are busy figuring out ways to pay the fiddler.

True, the glitter has not worn off for air travellers. There is no let-up in their acceptance of and enthusiasm for jet transportation. In a word—or in three words—they like it. This very fact has contributed to both the good and the bad parts of the financial picture.

TWA is having serious financing difficulties. Eastern, long the profit-leader of the major airlines, has fallen on lean days. Capital, unless the proposed merger with United is consummated shortly—a merger which is running into obstacles—may collapse entirely.

For the manufacturers of jet aircraft, still looking for profits in most cases, the way to those profits appears to be a write-off of losses.

For one of the bright aspects of the picture, take a look at Lockheed. Lockheed bounced back from its unprecedented losses of just three months ago at the half year period, to report the third quarter of this year as its most profitable in nearly six years.

Lockheed charged a $67 million write-off to its second quarter operations this year to take care of losses on the *Electra* turboprops. The company reported a net income of $5.5 million for the three months ended September 30th, earnings which confirmed the principal objective implicit in the write-off decision. Earnings equalled 74 cents per average share during the three-month period, compared with a net loss of $2,840,000 for the comparable 1959 quarter, which included a large write-off of excess *Electra* costs.

These same *Electras* were causing trouble for Eastern, long a paragon of profitability in the industry. Eastern has operated in the red for most of 1960. The main reasons have been the unpopularity of its large fleet of *Electra* aircraft, too few pure jets, and an expensive strike.

Once the most profitable of all major U.S. airlines, Eastern by the end of the third quarter had an operating deficit of $4.8 million on revenues of $196 million. The job of reversing the down-trend, which actually started in 1957 when Eastern first got competition on the rich New York-Miami route and its net plunged 36 percent, is a tough one.

Eastern, it appears, was simply unprepared for the switchover to jets. The line currently has only nine jets (DC-8s), and revenues on key routes are suffering. On the other hand, it has a fleet of 39 *Electras*, and after the third *Electra* accident last March the load factor fell off. Eastern has orders in for another seven Douglas DC-8s and for fifteen Boeing 720s to be delivered next year.

In a sense, Eastern is already paying for more than it has because it is carrying $165 million in long-term debt which was necessary to finance much of the fleet.

The line expects to wind up 1960 "barely in the black," and earnings for 1961 will continue to be depressed by the jet shortage and by the progressive withdrawal of *Electras* for alterations. Nevertheless, it looks forward to a modest profit in 1961 and should do better in 1962.

United Air Lines, on the other hand, reported third quarter earnings the highest in any three months in its history, with net income at $8,007,445 or $1.97 per average share outstanding. The nine-month net of $9,711,535 or $2.43 a share on revenues of $278.9 million still fell short, however, of the $14,357,785 or $3.84 per share on revenues of nearly $258 million reported a year ago.

The proposal to merge Capital Airlines into United is running into various difficulties. Delta and Eastern have opposed the move on the basis it will cut into their revenues on southern routes, and Delta, Northwest and Continental are indicating merger discussions in various shapes and forms in order to meet the competition which a Capital-United marriage would produce.

United has declared it is not interested in the merger unless it includes Capital's southern routes; the merger would be abandoned if it did not cover the original terms proposed.

In the meantime, Vickers-Armstrongs, holding a $34 million mortgage for Capital's *Viscount* fleet, said it would foreclose if Capital had not merged with United by February 1st, 1961. Capital countered by saying that if the merger is denied by the CAB the airline will collapse. Meanwhile, hearings continue.

While all this is going on, TWA has been having troubles with its jet program. The $300 million financing program under which Hughes, at one time in the negotiations, agreed to trustee the 78 percent stock interest which he holds through Hughes Tool Co., broke down, as he apparently changed his mind.

As a result, it is now indicated that the consortium of insurance companies and banks that was to have provided Hughes Tool Co. with a $168 million loan, might have to scrap the project. Both the Irving Trust Assurance Company, which heads the banking group, and the Equitable Life Assurance Company, which heads the insurance group, have declined to comment on the situation, which may still change in the on-again, off-again negotiation.

TWA is under contract to take delivery of nineteen 880 jets built for it by Convair. In the past, most of TWA's equipment has been financed through the extremely profitable Hughes Tool Co., but the jets at around $6 million each are too expensive for it to buy in quantity.

In an effort to put future orders on a profitable basis, the Convair Division of General Dynamics has decided to write-off remaining losses on its jet aircraft through the third quarter, a matter of $96 million before taxes. Of this total, $66 million is for the manufacturing cost in excess of sales price for 94 jet aircraft, $14 million is to write down the salvage value of used aircraft taken in trade, and the remaining $16 million for future research and development expenses.

The write-off gives General Dynamics' Convair Division a net loss of $26 million for the first three quarters of 1960 and cuts the quarterly dividend from 50 to 25 cents. The company expects a fourth quarter profit, but not enough to put it in the black for the year.

Douglas is going to write-off $30.5 million in connection with its DC-8 jet liner program. The company said this action should make possible a return to profitable operations in the fourth quarter of 1960 and in the coming year. This write-off resulted in a net loss of $13,099,000 for the quarter ended August 31st, compared with a deficit of $10,695,038 in the corresponding period last year. The net loss for the first nine months of 1960 was $21,868,045 compared with $25,704,958 a year earlier.

The Douglas write-off on the DC-8 consisted of $15.7 million in the third quarter for anticipated future development costs and $14.8 million for losses on aircraft delivered in the third quarter and future inventory write-downs on planes still to be delivered. For nine months, these charges amounted to $27,210,000 and $28,347,000 respectively.

Although the DC-8 has received enthusiastic passenger acceptance, current sales are reported as slow. The company's report to its stockholders said the DC-8 program represents perhaps the largest investment ever made in a single product by one company without benefit of Government assistance.

INTERNATIONAL MEETINGS AND CONFERENCES

Nov. 30th-Dec. 9th: AGARD Codification Panel Symposium on the effect of codification on the logistic support for the NATO nations. The Hague.

Dec. 5th-8th: American Rocket Society, 15th Annual Meeting and Astronautical Exposition. Washington, D.C.

Dec. 5th-11th: World Airline Employees Convention. Las Vegas, Nev.

Dec. 6th-8th: National Aviation Trades Association, Annual Meeting. Oklahoma City.

Dec. 7th: ATA, Board of Directors Meeting. Washington, D.C.

Dec. 8th: ATA, Membership Meeting. Washington, D.C.

Dec. 12th-15th: Atomic Industry Exhibition, held in conjunction with the Atomic Industrial Forum Annual Conference and the American Nuclear Society Winter Meeting. San Francisco, Calif.

Dec. 13th-15th: IRE, AIEE, Association for Computing Machinery, Tenth Annual Eastern Joint Computer Conference. New York.

Dec. 17th: Twenty-fourth Wright Brothers Lecture. Washington, D.C.

Dec. 26th-31st: American Association for the Advancement of Science, 127th Meeting. New York.

Dec. 28th-30th: Seventh King Orange International Model Plane Meet. Miami, Fla.

Jan. 9th-11th: Seventh National Symposium on Reliability and Quality Control. Philadelphia, Pa.

Jan. 9th-13th: Society of Automotive Engineers, International Congress and Exposition. Detroit, Mich.

Jan. 16th-18th: American Astronautical Society, Seventh Annual National Meeting. Dallas, Tex.

Jan. 21st: Society of Environmental Engineers, "Development of accelerated climatic tests." London.

Jan. 23rd-25th: Institute of the Aeronautical Sciences, 29th Annual Meeting. New York.

Jan. 24th: IATA Traffic Conferences, Special Conference on Freight Rates. Paris.

Feb. 1st-3rd: American Rocket Society, Solid Propellants Conference. Salt Lake City, Utah.

Feb. 1st-3rd: Institute of Radio Engineers, Second Winter Military Electronics Convention. Los Angeles, Calif.

Feb. 7th-9th: The Society of the Plastics Industry, 16th Reinforced Plastics Division Conference. Chicago, Ill.

Feb. 15th-17th: IRE International Solid-State Circuits Conference. Philadelphia, Pa.

Mar. 5th-9th: American Society of Mechanical Engineers, Sixth Annual Gas Turbine Conference and Exhibit. Washington, D.C.

Mar. 9th-10th: Institute of the Aeronautical Sciences, Flight Propulsion Meeting. Cleveland, Ohio (classified).

Mar. 9th-10th: Second Symposium on Engineering Aspects of Magnetohydrodynamics. Philadelphia, Pa.

Mar. 13th-15th: American Rocket Society, Flight Testing Conference. Los Angeles, Calif.

Mar. 13th-16th: American Rocket Society, Test, Operations and Support Conference. Los Angeles, Calif.

Mar. 13th-22nd: International Spring Fair. Utrecht.

Mar. 16th-18th: Fifth National Conference on Aviation Education. Washington, D.C.

Mar. 20th-23rd: Institute of Radio Engineers, International Convention. New York.

France's Aircraft Industry 1959/60

The 1959/60 annual report of the Union Syndicale des Industries Aéronautiques, submitted by Secretary General J. N. Adenot, reflects the energetic efforts being made by the industry to extend its production programme and to compensate in some degree for the fall-off in military contracts by increasing sales to the civil market.

The responsible planners are obviously not placing all their hopes for the future in military developments, such as those provided for by the French "programme law" on defence and the five-year plan for the constitution of a strike force which this law contains. They are soberly contemplating the fact that the credits for the development and production of aviation equipment for all armed services were cut from 111,600 million old francs ($223 million) in 1958 to 100,100 million ($200.2 million) in 1959 and 86,700 million ($173.4 million) in 1960.

The situation was already growing critical in 1958, when activity dropped by about 6 percent, with a corresponding decline in the number of employees. At first it appeared that this unfavourable trend would become more marked during 1959 and continue throughout the coming years. Contrary to all forebodings, however, the USIA report indicates that in 1959 and the first six months of 1960 the industry succeeded in gaining ground in the air transport market.

*

On the military side, production of the Dassault B.2 *Super Mystère* interceptor, the SO.4050 *Vautour* strike aircraft and the Fouga CM.175 *Zéphyr* trainer was phased out. Compensatory new production included the Dassault *Mirage III*, the prototype and pre-production versions of the *Mirage IV*, the *Etendard IV* and new orders for 15 Nord 2501 *Noratlas* and 70 Fouga CM.170R *Magisters*. Nevertheless, if the French industry had not met with success in its energetic efforts to capture new markets, the three-year period 1958-1960 could have brought a 25 percent recession in business compared with 1957.

Ninety percent of the extended activity is due to the Sud-Aviation *Caravelle*, which at present gives employment to some 20,000 technicians and factory hands. By the end of 1959, employment in *Caravelle* production was 250,000 man-hours per month higher than at the end of 1958. By June 30th, 1960 eight countries had placed 91 firm orders and 38 options for *Caravelles*.* And Sud-Aviation has high hopes for the next few years, based on the world market requirement for the replacement of 1,456 medium-haul aircraft of the DC-4, *Constellation*, Convair 240/440 and *Viscount* types (Europe 331, Asia 154, Africa and Australia 43 each, North America 598 and Latin America 287).

Engine manufacturers found the transition from military to civil requirements more difficult than the airframe manufacturers; in recent years production had been almost entirely devoted to military requirements, especially in the medium- and high-power brackets. SNECMA has enjoyed considerable success with the Mark 8 and Mark 9 versions of the *Atar* to equip the *Mirage III* and *Etendard IV*, and has concluded a very promising agreement with Pratt & Whitney. The new arrangement will give SNECMA the possibility of re-entering the civil market—initially with overhaul and component manufacture—and the company forecasts annual turnover of the order of NF 50 million ($10 million) over the next few years.

Hispano Suiza, which has undertaken certain measures to rationalize production, is also in a favourable position with overhaul contracts for the *Verdon*, *Marboré* and *Avon* engines, and with the production of *Caravelle* landing gear and SEPR rockets for the *Mirage III*.

Potez has launched quantity production of two engines for the light aircraft market, and Turboméca has a widely diversified production programme. Home and overseas demands for the *Marboré II*, *Bastan*, *Palouste* and *Artouste* small turbine engines have resulted in the placing of important sub-contracts with other French companies.

Another trump card is helicopter production, with firm orders for a total of 800 *Djinns*, *Alouettes* and S-58s built or on order at Sud-Aviation by June 30th.

Missile business is also mounting, with Nord-Aviation reporting orders for over 50,000 SS.10s and SS.11s, valued at more than NF 300 million ($60 million). Nord-Aviation introduced a third assembly line for production of air-to-air and air-to-surface weapons during the period.

But, despite this partial success in the military sector, the military share of total turnover dropped from 80 percent in 1957 to 55 percent in 1960.

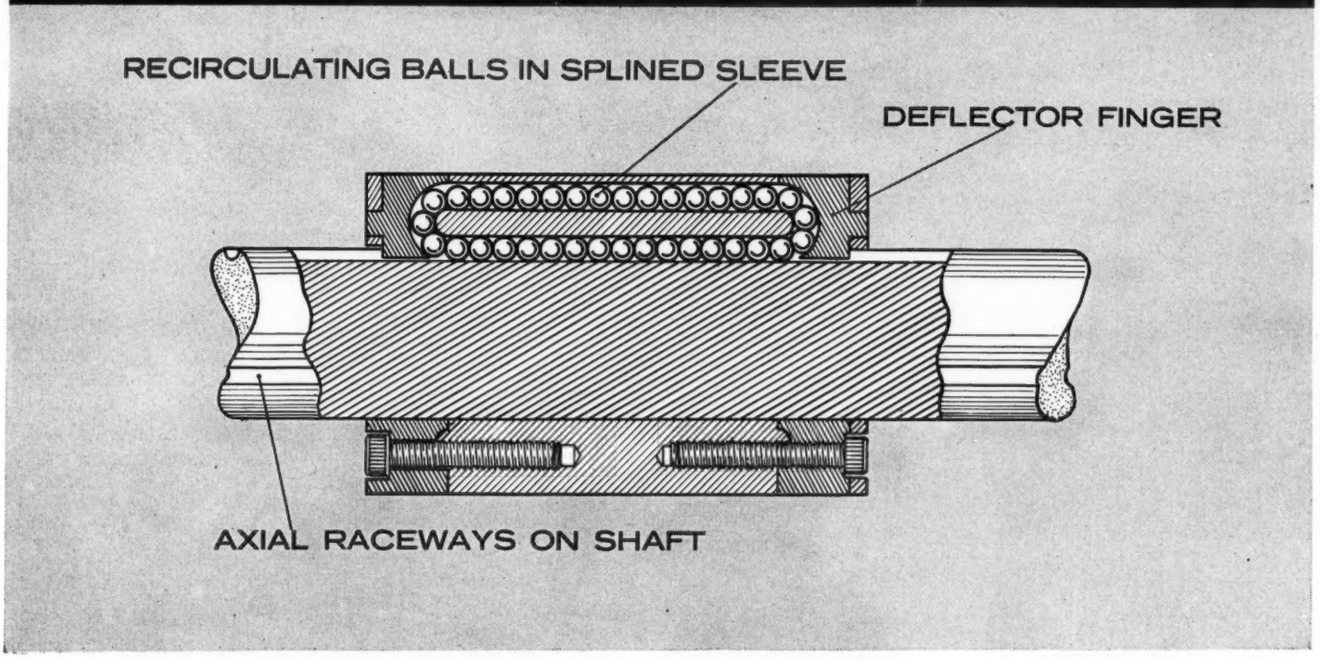
In conclusion, mention should be made of the tremendous increase in French aviation exports, which have accounted for 20 to 25 percent of total turnover in recent years. In 1958 export orders totalled 38,000 million old francs ($76 million), but this figure had increased to 45,000 million ($90 million) in 1959 and is expected to reach about 100,000 million ($200 million) in the current year. In 1958 Dassault already stood in 10th place and Nord-Aviation in 29th in the list of France's exporting businesses. Breguet has received a major order from India for the 1050 *Alizé* anti-submarine aircraft, and Morane-Saulnier has booked orders from Argentina, Brazil and Peru for considerable numbers of MS.760 *Paris* executive aircraft.

*

Admittedly, the French aircraft industry is not yet over the hill. Further substantial efforts will be necessary before large-scale quantity production can become rewarding. But the USIA report is justified in stressing the outstanding improvement over earlier lean years with their pocket-size contracts for types such as the *Armagnac* and *Bretagne*.

* This figure has recently been increased to 101 firm orders.

Ball splines, over 90% efficient, operate at -55°C to 450°C and over . . .



. . . ANOTHER ENGINEERING ADVANCE FROM BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce ball splines.* These ball splines achieve a minimum efficiency of 90% and they can operate within a temperature range of —55° C to over 450° C.

Machined and ground to the highest standards of precision, Bristol Siddeley ball splines are much more efficient in operation than conventional splines. They substitute a recirculating stream of precision-ground balls, rolling along specially contoured grooves, for the solid key and keyway. This arrangement reduces friction to a minimum when the spline assembly is subjected to linear, torque and bending loads. It also gives optimum smoothness and a very fine degree of positioning accuracy. When compared to conventional spline mechanisms, Bristol Siddeley ball splines require a much smaller power source; provide a predictable operating life; need much less maintenance; and give long, trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification and each unit is specially designed for its particular application. For the splines can be made with angular pre-loading, with multiple circuits, and with telescopic extensions. Bristol Siddeley splines have been proved as the most efficient method of minimising friction when high torsional and bending loads are imposed during linear movement in many engineering applications. They have been designed already with rated operating torque capacities of 50,000 lb/in (200,000 lb/in maximum static torque) but the maximum potential operating torque is, in most cases, limited only by the requirement.

Bristol Siddeley ball screws

reduce the power required for actuation by as much as 80%. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion when converting rotary drive into linear output.

**Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to: J. B. Starky, Sales Manager (Ball Screws and Splines), Bristol Siddeley Engines Limited, PO Box 17, Coventry, England.

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FOR AIR TRAFFIC CONTROL

The TMA 403 electronic memory tube has transformed radar operations :

by **converting** the fainter radar image into a brilliant television image, which controllers can more easily observe in daylight ;

by **retaining** the image showing the aircraft's route for several minutes, at the operator's discretion ;

by making it possible to **superimpose** on the image various service symbols, aircraft identifications, geographical features . . .

by making it possible to **transmit** the complete radar picture, via coaxial cable or long-range radio links, like a normal television programme.

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Compagnie générale CSF de télégraphie Sans Fil

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CSF radar for air traffic control

RAPY

CSF (Compagnie générale de télégraphie Sans Fil) constructed the new area control radar at Orly. The installation was officially inaugurated in March 1960 by the Minister of Transport, R. Buron.

The equipment marks a great advance on its predecessors. It is the first in the world to provide the new radar coverage specified by ICAO (International Civil Aviation Organization) to satisfy the requirements of commercial jet aircraft. The CSF radar actually consists of two identical radars with a total power of 4 million watts, combined in "diversity." This system, which was developed by the company, provides gap-free coverage up to 300 miles. The antenna of this radar incorporates a circular polarization system which gives effective suppression of rain clutter.

The French Directorate of Air Navigation has selected this equipment for installation at the French area control centres (Orly, Marseilles, Bordeaux and Lyons).

CSF also supplies airport radar, where the necessity for surveillance of a compact area demands different range characteristics.

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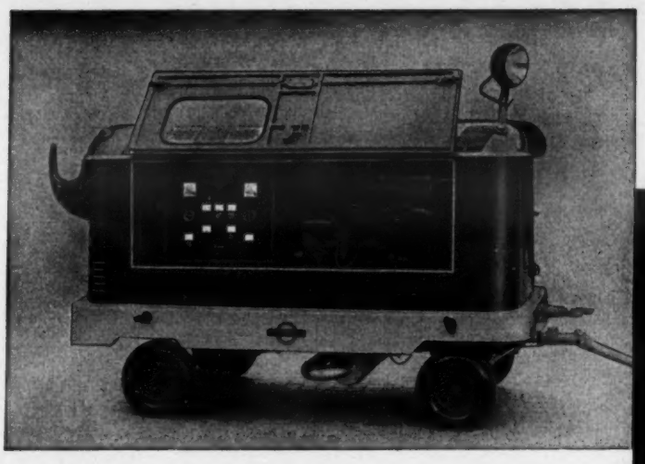
STRÜVER GROUND POWER SUPPLY SYSTEMS FOR AIRLINERS



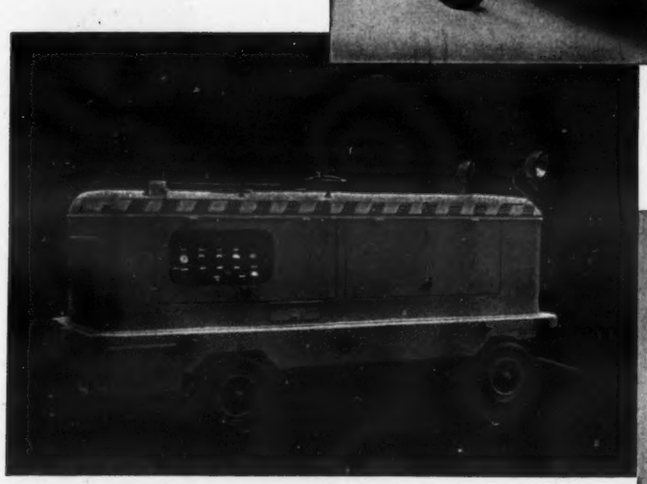
◀ **ROLSTARTER** This equipment is used at many airports in Germany and other countries to start piston-engine aircraft and the VISCOUNT.

JET-ELECTRIC 75 ▶

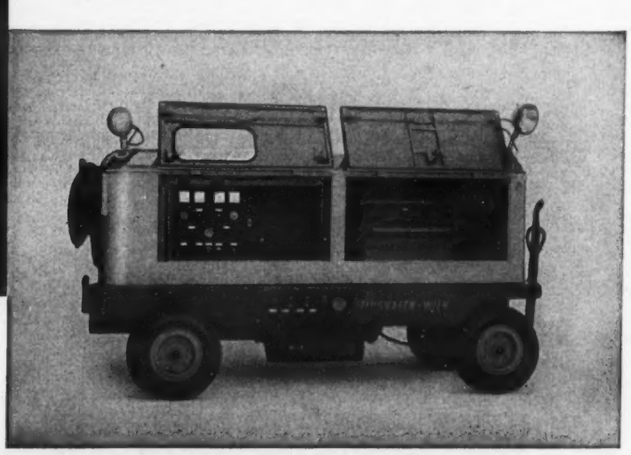
Self-propelled, diesel-powered equipment for supplying power to the BOEING 707, DC-8 and LOCKHEED ELECTRA requiring 400 c/s three-phase, 120/208 V.

◀ **JET-FREQUENTA**

75 kVA frequency transformer for supplying jet aircraft with 400 c/s three-phase, 120/208 V, from a permanently installed underground cable system of normal voltage.



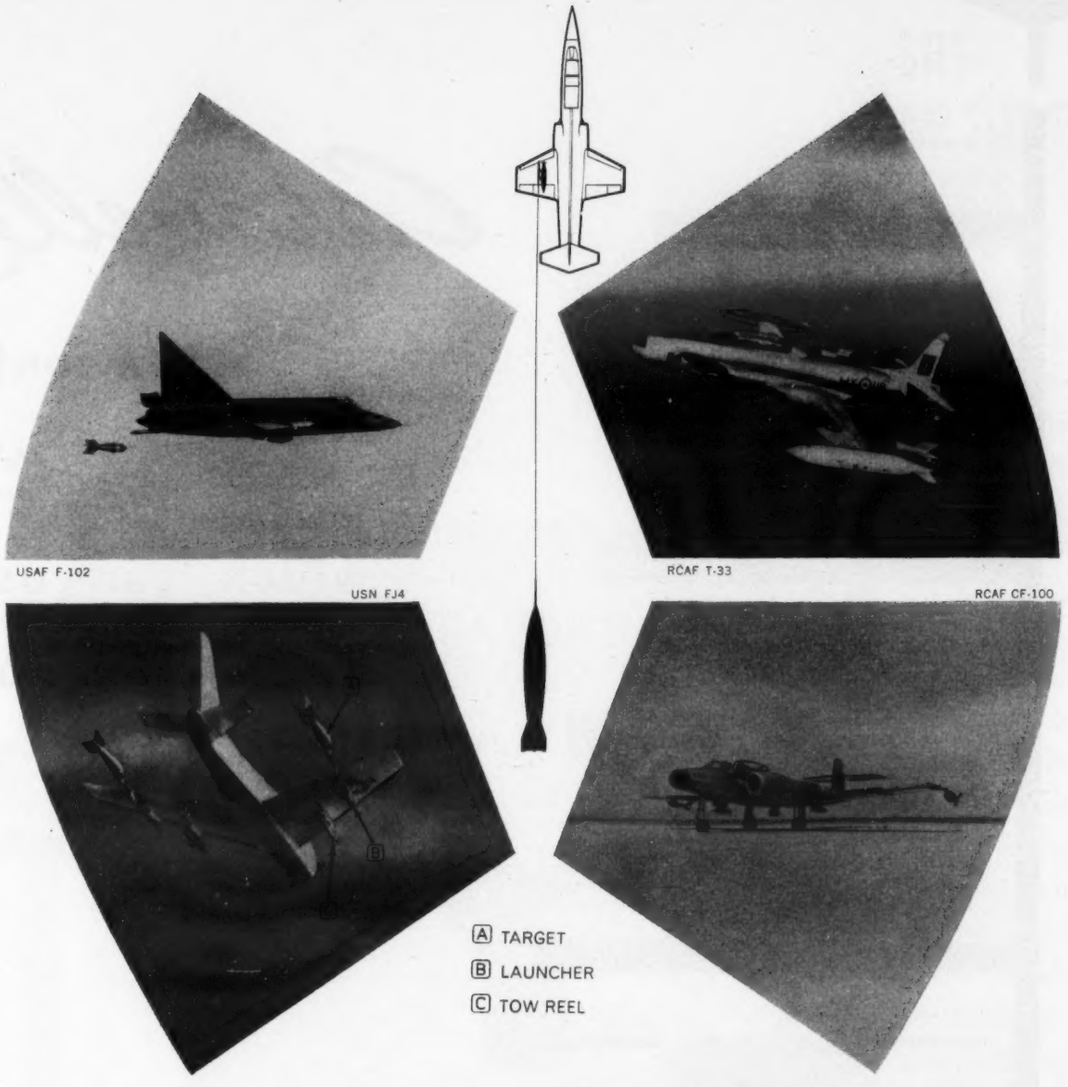
◀ **JET-AIRSTARTER** Diesel compressor unit for compressed air starting of BOEING 707, DC-8 and LOCKHEED ELECTRA aircraft.



DUO-VOLTA ▶

Diesel dual-voltage unit with separate d.c. generators for 112 and 28 V, for starting and supplying power to the CARAVELLE and COMET jets, as well as the BRITANNIA and VANGUARD turboprops.

AD. STRÜVER KG AGGREGATEBAU HAMBURG



Supersonic and Subsonic Tow-Target Systems from Fairey

Fairey Engineering Ltd. has signed a distributorship agreement with Del Mar Engineering Laboratories to distribute high performance tow-target systems for use in air-to-air and surface-to-air weapons training. The agreement covers distribution of this new equipment in Great Britain, the Middle East (except Israel), South Africa, and Australia (through Fairey Aviation Co. of Australasia Pty. Ltd.). The agreement also covers Europe, except for Germany, Switzerland and Scandinavia.

The basic component of the system is a lightweight subsonic or supersonic tow target, which can be equipped with flares for the homing of infra-red missiles, as well as with special devices to enable the fighter pilot to find the target visually at long range. Provision is also made in the target to measure the closest approach of the weapons to the target when a direct hit is not obtained.

Various tow reels will hold up to 6½ miles of fine wire tow line. Target launchers carry, launch, and recover the targets in flight. The equipment is readily installed on, or removed from, any operational fighter aircraft.

These inexpensive RADOP® (radar/optical) weapons training systems, developed by Del Mar Engineering Laboratories are already in extensive use by the military air services of the United States, Canada, and other NATO nations. Now, the distribution of this equipment by Fairey Engineering will make the procurement and servicing of these systems much more convenient to free world air units located in Great Britain and the Western European, African, and Australian areas.

For more information, write to Fairey Engineering Ltd., Heston, Middlesex, England.

Del Mar ENGINEERING LABORATORIES

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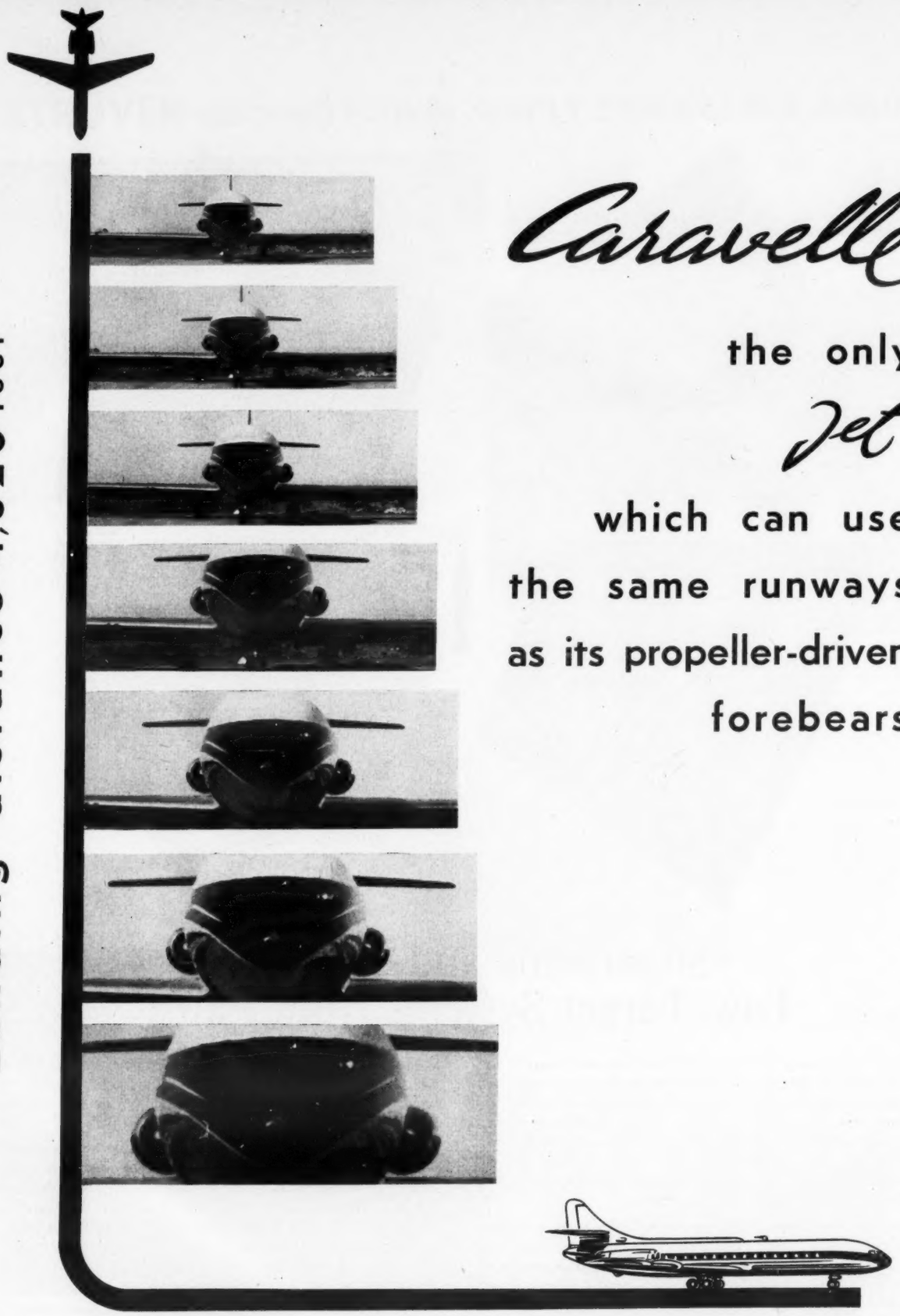

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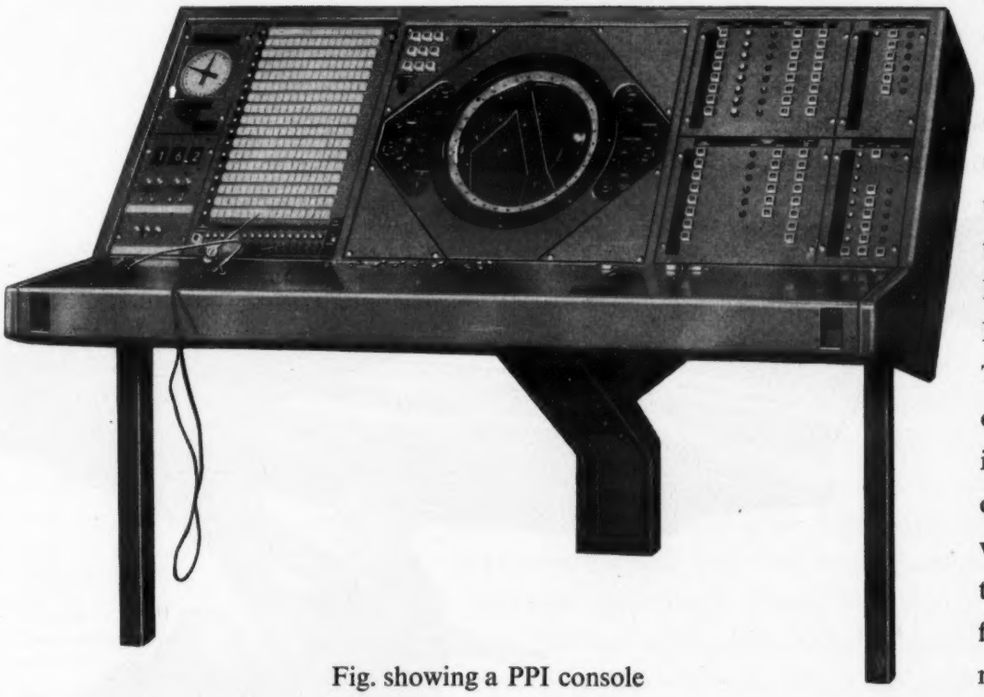

Fig. showing a PPI console

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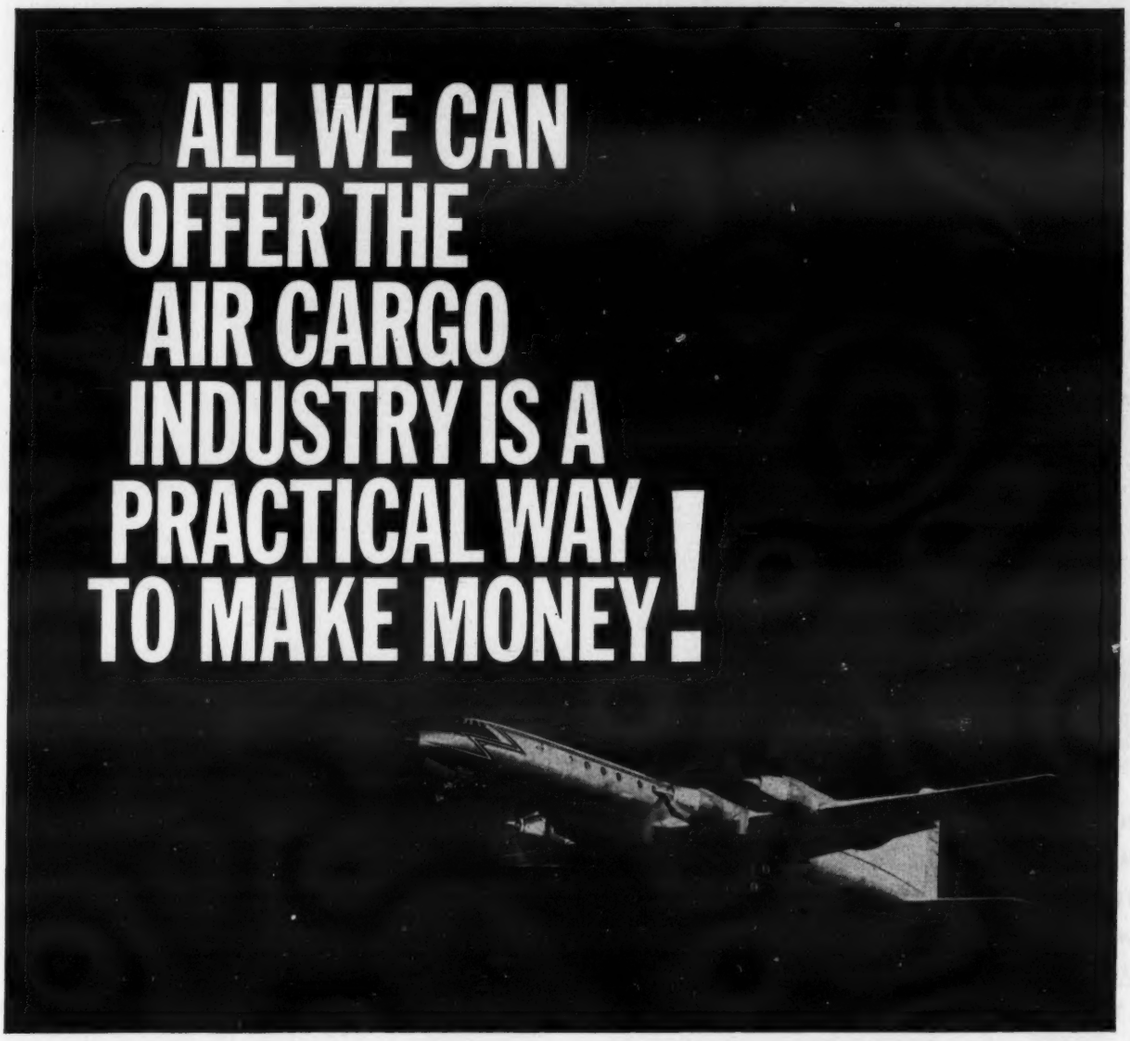

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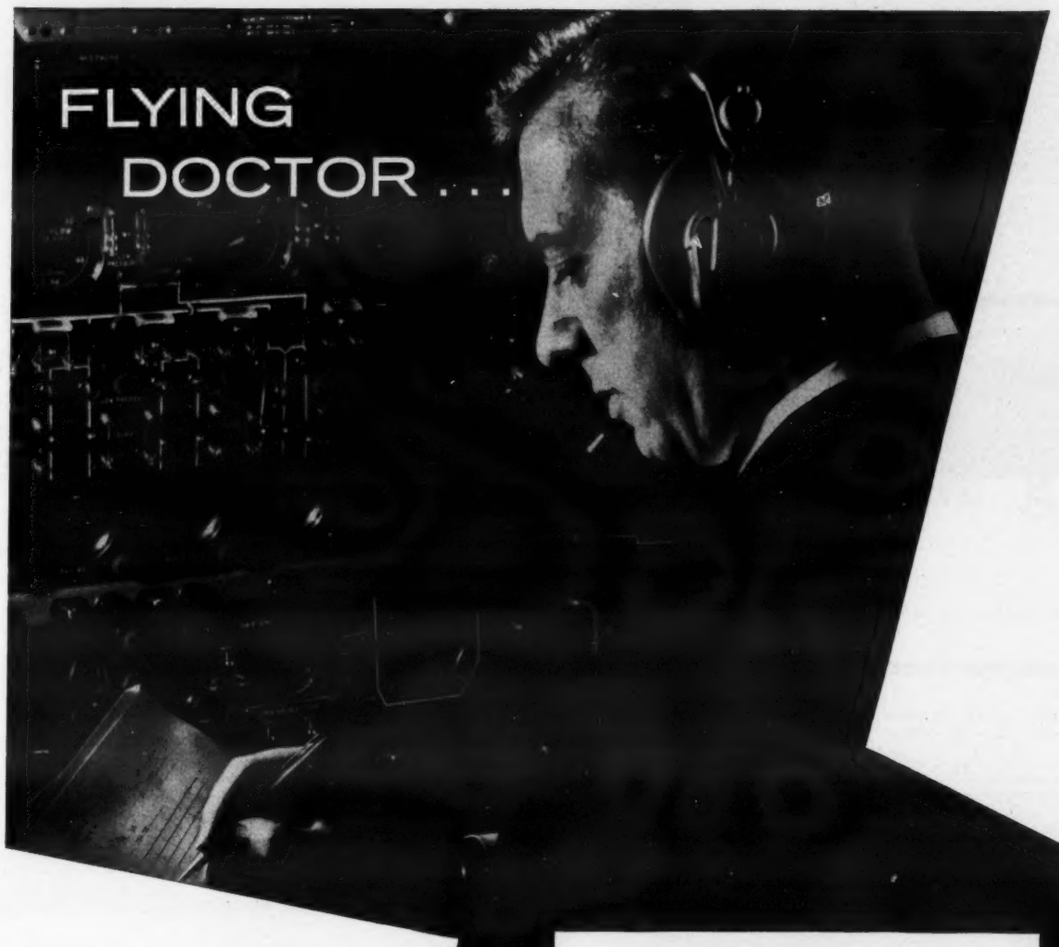

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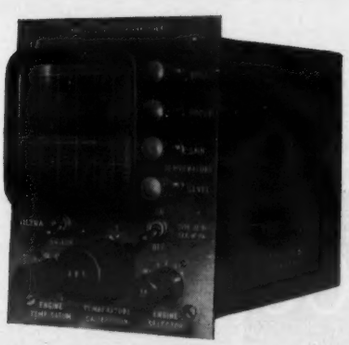

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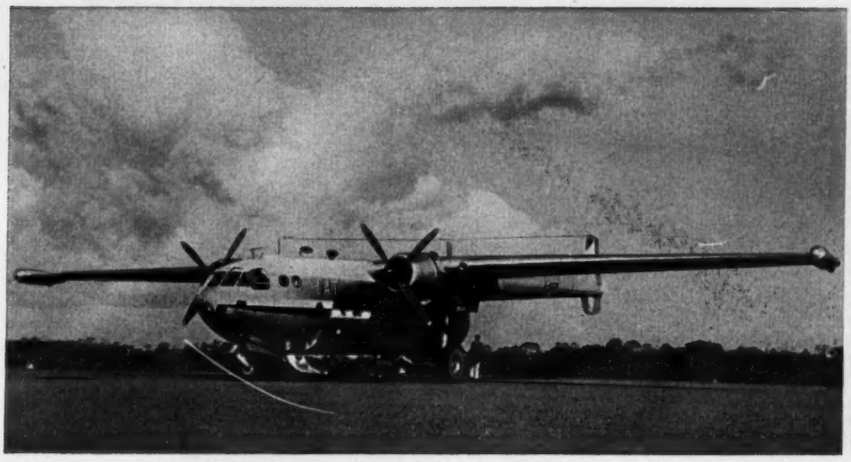

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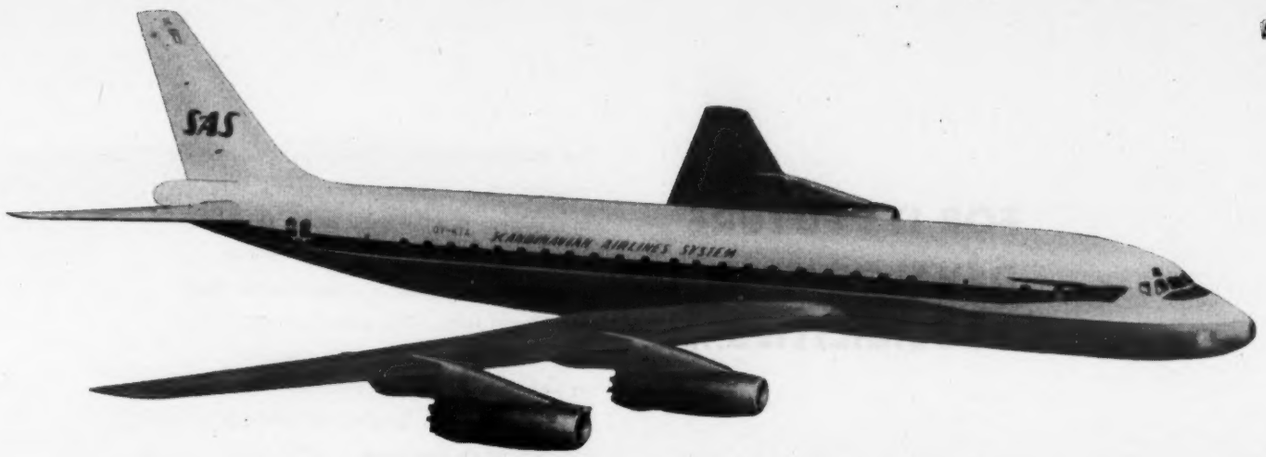

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Take-off, flight and landing must be made with the utmost safety; comfort and well-being must characterize the journey.

Costly modern aircraft require ground equipment which operates fast and efficiently.

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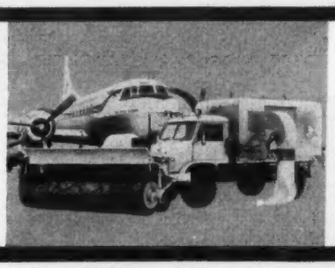
VERRO MINOR. Automatic sweeper for indoor use or small areas out of doors. Swept width 4.5 ft.; capacity of dirt hopper 44 gallons.



VENTO. Runway sweeper with rotating forward cylindrical brush and powerful blower.

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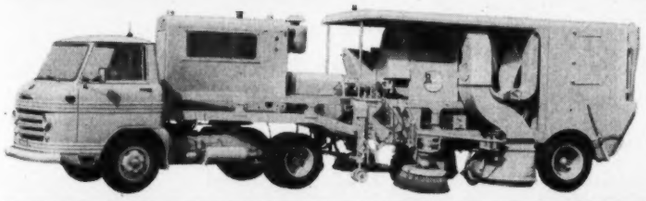
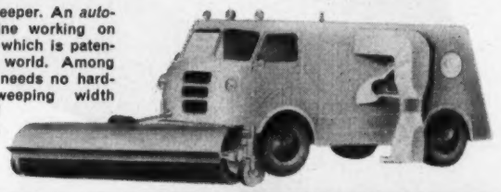


VERRO. Runway sweeper. An *automatic* suction machine working on the VERRO principle which is patented throughout the world. Among other advantages, it needs no hard-to-clean filters. Sweeping width 150 in.; capacity of dirt hopper 160 cu.ft.

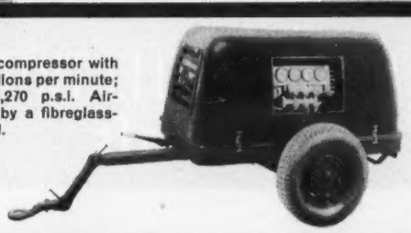


WACAR. Fresh water truck with corrosion-proof tank. Pump delivery 7.5 gallons per minute; water head 78.5 ft.

LACAR. Lavatory truck with one main tank, one flush water tank, two tanks for chemical solution and alcohol.

CLECAR. Cleaning car with ample room for cleaning equipment of various kinds. Equipped with water tank.

FP 25. High-pressure compressor with an air delivery of 110 gallons per minute; maximum pressure 4,270 p.s.i. Air-cooled and protected by a fibreglass-reinforced plastic hood.



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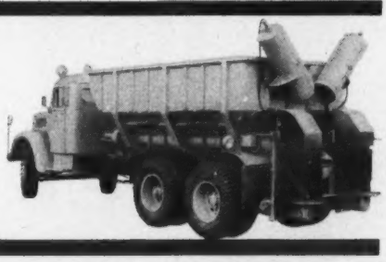

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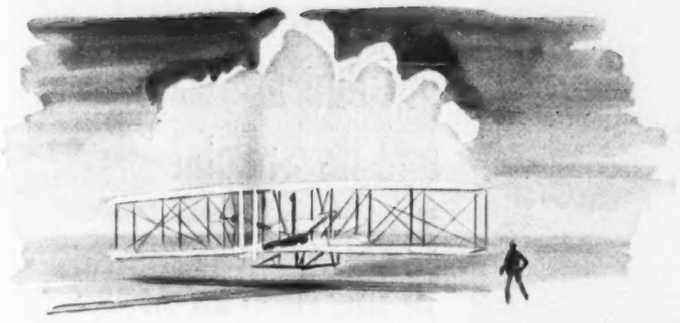


"For some years," wrote Wilbur Wright in 1900 to his friend and mentor Octave Chanute, "I have been afflicted with the belief that flight is possible to man. My disease has increased in severity and I feel that it will soon cost me an increased amount of money if not my life." Three years later, Orville Wright was able to telegraph to his father, Bishop Milton Wright, "Success four flights Thursday morning all against twenty-one miles wind started from level with engine power alone average speed through air thirty-one miles longest 57 seconds inform press home Christmas."

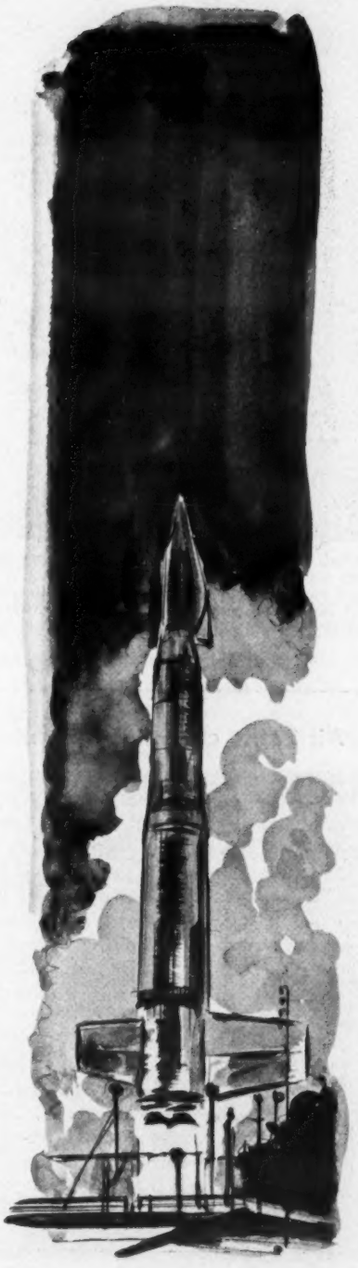
At the end of this year of grace 1960 mankind stands near the end of another, equally arduous, period of development, which may well one day find its climax in a telegram reading: "Safely returned to earth from successful space voyage. Home Christmas."

Once again things may move faster than expected. Only a year or so ago many serious observers felt that it would be some considerable time before attempts at manned space flight could be made. Today, the big question is which nation will be the first to succeed in this venture.

Contrary to the Wright Brothers' intentions, powered flight has been developed largely for military ends, and in this way has brought much suffering to mankind. May space flight lead only to friendly rivalry among the peoples of the world! Such is our wish for 1961.

INTERAVIA
Publishers and Editors

Geneva, December 1960



Air Traffic Control in General and its Special Problems in the Geneva Area

By Maurice A. Treyer, Head of the Traffic Control Services, Radio-Suisse, Geneva

Geneva's Cointrin Intercontinental Airport, seen from the southwest: The airport (runway threshold) lies 1,365 feet above sea level. The main runway (QFU 05/23) is 12,795 feet long and has an absolutely obstruction-free approach over Lake Geneva for bad weather landings. In addition, there is a short, parallel grass runway for light aircraft, which must, however, be equipped with voice radio. Aircraft without VHF equipment may use the airport only with special authorization.

Air traffic control is becoming a question of life or death for aviation

How urgent this question is has just been demonstrated so to speak on the highest level, when the Comet *carrying Queen Elizabeth and Prince Philip from Copenhagen to London narrowly missed colliding with two jet fighters. The* Comet *was flying along a Purple Airway—an airway reserved for the royal flight and hence closed to all other users of the airspace—when the pilot saw the two jets diving on to him. At the last second the jets climbed away . . . adding yet another "near miss" to the growing list. One's thoughts also turn to the incident at Orly Airport, Paris, last May, when a sports biplane collided with an Air Algérie* Caravelle. *Fortunately the* Caravelle *captain managed to land his damaged aircraft safely, to the amazement of all spectators.*

These and many other incidents show that energetic measures must be taken as a matter of urgency to improve the air traffic control system. For whoever fails to avert avoidable danger is guilty of criminal negligence.

The present issue on air traffic control opens with a contribution from a leading Swiss expert, Maurice Treyer, head of the air traffic control services at Geneva Airport, who writes in easily comprehensible terms about traffic control problems in general and the special problems faced by his area in particular. The practical side is then discussed in the articles by Interavia *writers E. K. Barnes and D. Ebert, who describe in turn a North Atlantic flight from Zurich to New York by Swissair DC-8, and the highly responsible work of a controller in areas of dense traffic.*

If the issue leads to some serious thinking on how to improve the present state of affairs, it will have served its purpose.—Editors

I. Present situation and trends

The readers of *Interavia* are well aware of the problems facing air traffic. Nevertheless, it is perhaps not out of place to begin an article devoted to the control of this traffic with a recapitulation of some of the basic principles which today govern the activities of the control services. For it is not unusual to hear opinions expressed, even in aeronautical circles, which plainly reveal that their authors have lost sight of the rules worked out by the International Civil Aviation Organization.

Annex 11 to the Convention on International Civil Aviation states that the object of the air traffic services is to prevent collisions between aircraft in the air, and between aircraft and obstructions on the airfield; to expedite and maintain an orderly flow of air traffic; to supply such advice and information as will assist in ensuring the safety and efficiency of flights; and to alert the appropriate search and rescue organizations in case of need.

These urbane definitions conceal a tremendous task which is constantly growing in magnitude as the number of aircraft and their speed ranges increase. But traffic control is not provided for all flights. Annex 2 to the above-mentioned Chicago Convention makes a distinction between controlled and non-controlled airspace; the former consists in essentials of the aerodrome traffic zones (CTRs), terminal areas (TMAs) and the airways (AWYs). Traffic control is provided

only in the controlled airspace, and even then only if the pilot has undertaken to fly under Instrument Flight Rules—which applies to practically all scheduled airline flights. A pilot flying under Visual Flight Rules is responsible for his own safety, with the aid of the ground services, who will provide him with information on known traffic and on meteorological conditions, but do not assume any responsibility for him. An exception is made, however, in the favour of pilots flying VFR in the environs of a controlled airport.

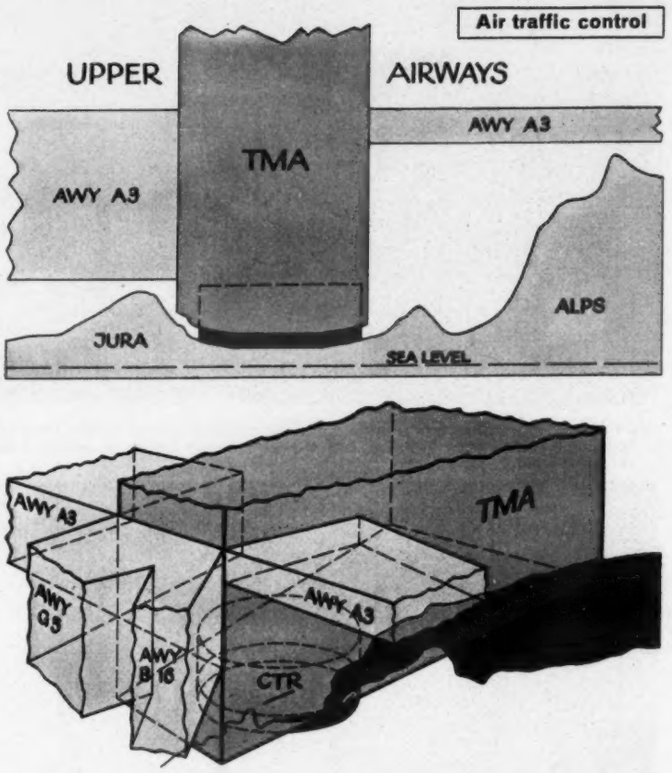
The methods of air traffic control in use today are too well known to necessitate a detailed description. I shall therefore restrict myself to a few general remarks. In so doing, I would stress the remarkable degree of standardization achieved thanks to the work of the International Civil Aviation Organization. Navigation equipment and procedures, control and communications are, at different levels of development, similar throughout the world.

Each IFR flight in controlled airspace is announced in advance by the pilot, by means of a flight plan indicating precisely the projected route, the desired altitudes, speed and equipment of his aircraft. If the proposed flight path is free, all is well; but if it is already blocked, Control must suggest a different altitude or a deviation or order the pilot to wait.

Having received his clearance, the pilot remains in radio contact with the controller. He follows his route and must report his position accurately as he passes over each radio aid along this route. He may not change direction or altitude unless authorized to do so. His progress is followed, from radio aid to radio aid, by the control services of each area he crosses, who place a progress strip for each aircraft on the progress board, calculate the time of flight for each stage and authorize the pilot to continue the flight provided there is the international standard separation between all the aircraft flying IFR in their area: a separation of 5 minutes for the slowest aircraft and of 10 minutes for the fastest, or of 1,000 feet in altitude.

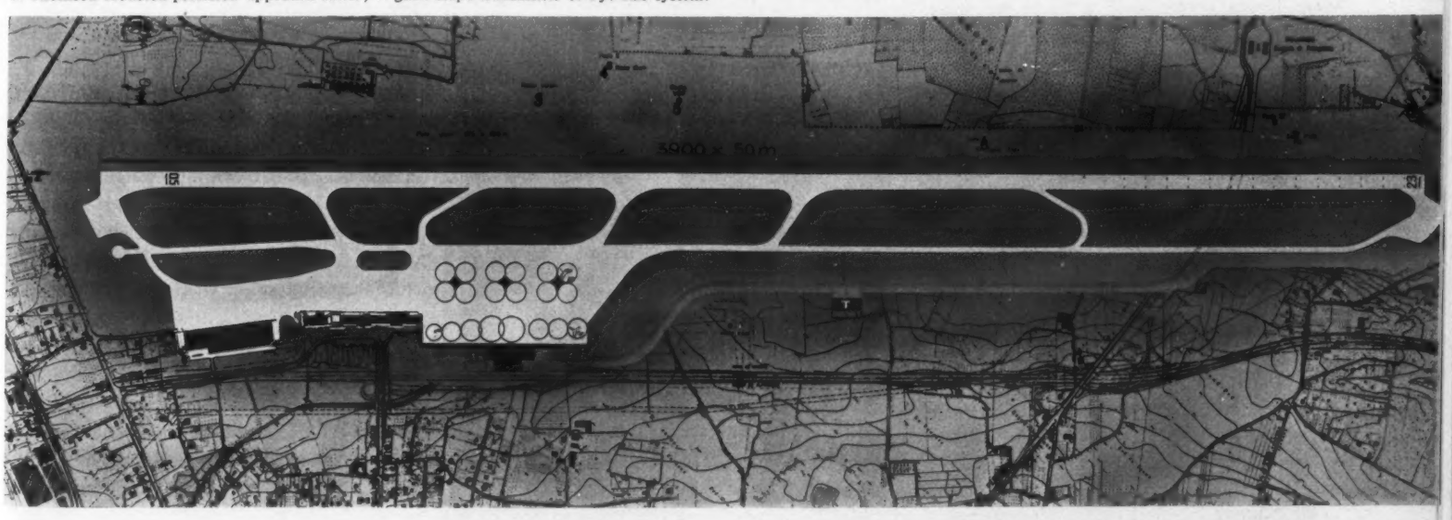
This is where matters become complicated, owing on the one hand to the navigation errors which can occur with the instruments at present available, and on the other to the very great difference between the speeds of the aircraft concerned. Pity the poor jet pilot whose climb or descent path is obstructed by snails crawling along at 3 or 4 miles a minute, when he covers nearly 10 miles in the same time. Pity the poor controller who must make sure there is a separation of 10 minutes between aircraft at the same altitude, when their speeds not only differ from one type of aircraft to another but also vary for the same type of aircraft depending on the flight phase. Ten minutes separation, or 75 to 100 miles of route for a jet, what prodigality! How easy it is to understand that the immensity of the skies, as the poets have it, soon becomes as congested as Piccadilly Circus or the Champs-Elysées.

In the terminal areas, the situation is still more difficult, as here aircraft climb and descend at rates varying between 400 and



Simplified cutaway drawing and diagram of controlled airspace in the Geneva area: the *cylindrical aerodrome area (CTR)* extends from ground level up to 6,000 feet and has a diameter of 13 nautical miles. It projects into the trough-shaped *terminal area (TMA)*, whose lower limit is at 1,000 feet above ground level (no upper limit). A total of seven *lower airways (AWYs)* lead into the TMA, though only four are shown in the diagram (below) and two in the cutaway drawing (above). The upper limits of these airways are in each case at 20,000 feet above sea level, while the lower limits depend on the height of the ground obstructions (Jura and Alps). Above 20,000 feet, finally, are the *upper airways*.

Location of Geneva air traffic control installations. Key: 1. control tower (TWR), approach control (APP), area control centre (ACC) and telecommunications services (COM); 2. localizer of the Pye ILS system; 3. Marconi S. 264 surveillance radar (50-cm); 4. Thomson-Houston TH. D. 1081 surveillance radar (10-cm); 5. Standard PV 1B VHF D/F station; 6. Thomson-Houston precision approach radar; 7. glide slope transmitter of Pye ILS system.



View of the control tower and the lower directional antenna reflector for the 4,000 Mc/s radio link (Decca) to the weather radar on the Dôle. Left, the two antenna reflectors for the 24-channel 2,000 Mc/s radio link (Standard) for voice and control connections.

Inside the control tower.

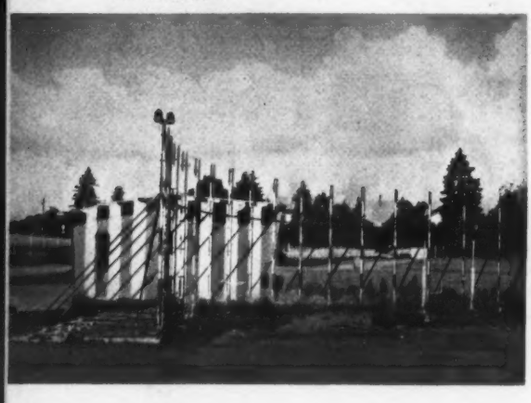
4,000 feet per minute[1]. Here, too, each jet pilot wants to be given the optimum trajectory, namely the one which will enable him to keep the fuel appetite of his fabulous machine within reasonable limits. A climb at an unfavourable configuration may result in the consumption of an extra ton of kerosene. Imagine, then, the dilemmas faced by controllers who are anxious to assist pilots, but have to apply standards which oblige them constantly to take measures which complicate the existence of those they are supposed to help. Fortunately, the progress made in the design of surveillance radars enables increasing advantage to be taken of this marvellous aid thanks to which traffic can be speeded up, separation standards can be reduced, and flight safety increased.

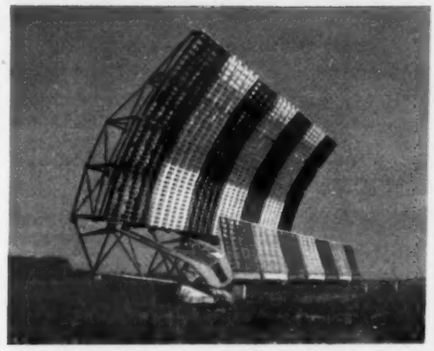
But radar is not a universal cure and there can be no question of using it to control all the traffic. In particular it is used to speed up the descent and the climb-out, and it is also being used to simplify changes of altitude en route. To make it even more efficient it is essential that an international agreement should be quickly established on the choice and the introduction into service of secondary radar (already mandatory on certain sectors of airspace in the United States) which by enabling the aircraft to be easily identified, increases the efficiency of the primary radar. Only when this requirement is satisfied will it be possible to profit from the jet aircraft to the fullest extent. It is also extremely desirable that an information transmission system from air to ground, working by means of the secondary radar responses, should be standardized and brought into operation.

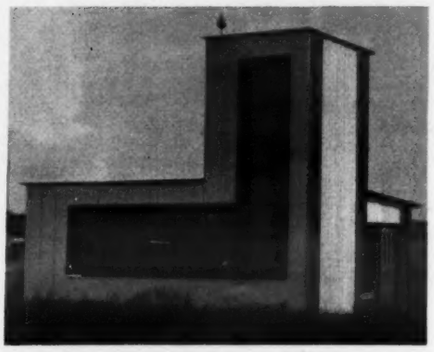
Even prior to the introduction of the jet aircraft into operation, the air traffic control services were criticized for not developing at the same rate as the volume of traffic, and in keeping with the characteristics of the new aircraft. This is only partially true. Certainly there are many things which can and must be improved in control, but at the same time there are also the navigation aids which have not kept pace with the increase in the speed of the aircraft. This has almost quadrupled since 1945, while the accuracy of the navigation systems has remained, to all intents and purposes, the same. Although a technical marvel, the present-day jet aircraft, is, with due respect to its designers, an exceedingly difficult machine to exploit profitably. To achieve its maximum productivity it must have unrestricted use of the airspace; it should be able to take off and climb on the ideal flight path in relation to its weight, its journey distance and the temperature and humidity of the air. During the flight it should be able to adjust its altitude, in relation to its diminishing weight and the prevailing weather conditions, to the level where its fuel consumption is at its minimum. At the destination it should be able to descend without restriction on an ideal flight path and to land without delay. But it is not the only one; hundreds of its kind travel along the air routes. For a long time to come traffic restrictions will be inevitable, no matter how quickly the solutions which are at present being designed or produced are brought into service. There is no miraculous remedy and

[1] In the majority of Western European countries and throughout the English-speaking world, altitudes and vertical separations are indicated in feet (1 foot = 305 mm); vertical speeds in feet per minute, 400 ft/min equalling 2 metres/sec, thus 4,000 ft/min = 20 m/sec. Altimeters and vertical speed indicators are always graduated in feet.

Localizer (left) and glide slope transmitter for the Pye ILS installation.





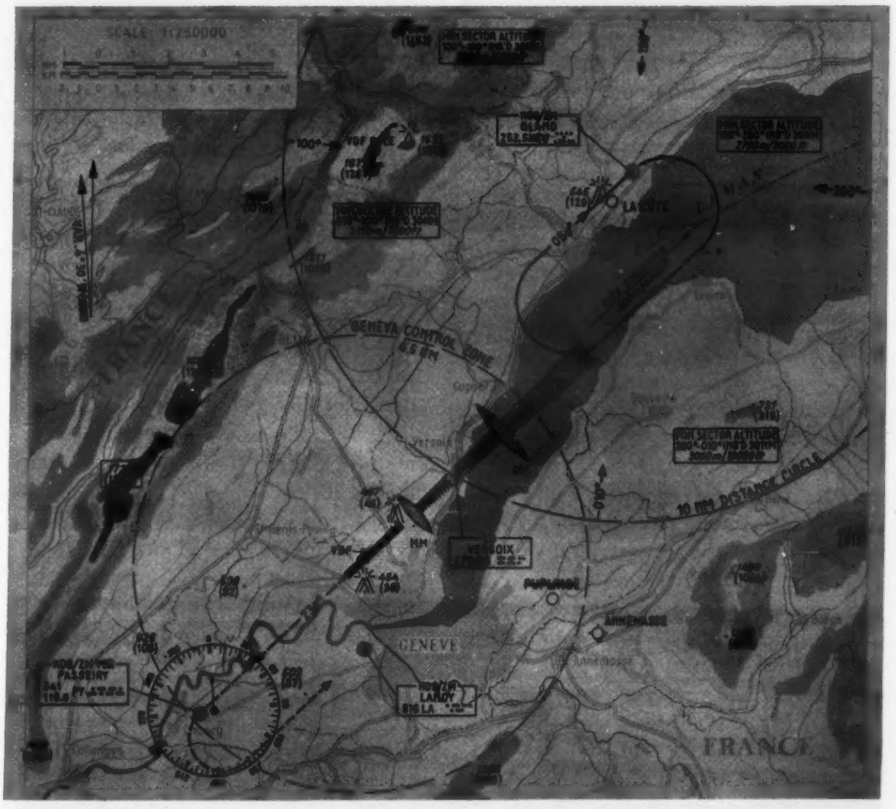


The three radar installations on the airport: left to right, Thomson-Houston TH.D. 1081 10-cm surveillance radar; Marconi S. 264 50-cm surveillance radar; Thomson-Houston precision approach radar.

these facts must be stated bluntly, if only to prevent all the difficulties of exploitation of the modern jet being attributed solely to air traffic control.

Perhaps I will be accused of pessimism and of being unconstructive if I choose to remain in the realms of hard reality, and ask all those who work in the various fields of aviation to reconsider all the problems which face this industry. The constructors, the electronic engineers, the pilots, the controllers, the operating companies and the airport authorities must unite their efforts and at the same time recognize their own weaknesses.

I have spoken of hard reality; what is this in fact? It is the presence on large airports of dozens of aircraft awaiting take-off clearance for 20, 40 or 60 minutes. On certain air routes it is the number of pilots who cannot obtain the authorization for the desired optimum flight path; it is the fact that timetables are only maintained with difficulty, compelling the operating companies to make continuous modifications to the aircraft operation plans. Why is this? Is it not because existing airports resemble railway stations equipped with one or two platforms and possessing only two or three arrival and departure tracks, but which are compelled nevertheless to carry the traffic of a capital city?



Instrument Approach Chart for Geneva airport (ICAO standard): Aircraft approach from the Gland area at a minimum altitude of 4,000 feet above sea level, perhaps after having made several holding circuits above the Gland beacon and its Z-marker at a prescribed altitude. They then steer on a magnetic course of 230° to the instrument runway, on a glide path of 3° inclination. If the pilot breaks off the approach, he must climb and fly straight to the VOR (or MF omni-directional transmitter and Z-marker) at Passeiry, then turn left onto the reciprocal and take his place once more in the "landing circus" at Gland.

II. Special problems in the Geneva area

After this long but necessary introduction, it is the moment to come to the main point of this article, the special problems of Geneva from the point of view of air traffic control, communications and radio facilities.

As I have already said, the means and the procedures are the same everywhere, so that there are no special secrets to be revealed. But the topographical situation of Geneva necessitates the adoption of systems which are more complicated than those employed in other regions. The airport is ideally situated because the instrument approach course is entirely free of obstacles; but it is encircled by mountains, which prevent initial approaches

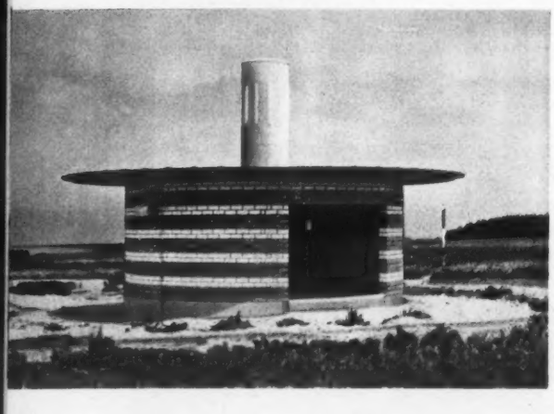
Inside the Geneva approach control: Left, the desk for conventional control of arrivals and departures, with VHF D/F equipment and clock; next the screens for the 10-cm and 50-cm radars; far right, the console for the precision approach radar.

The Gland MF non-directional beacon (NDB) is combined with a VHF marker (Z-marker). It marks the junction of all the airways passing through the Geneva area and serves as turn-off point for aircraft at medium altitudes wishing to land at Geneva. It also marks the holding area.

being made at low altitude, from the majority of directions. It has only a single runway, 3,900 metres (12,800 feet) in length, as the prevailing winds come from either the north-east or the south-west. Situated between the chain of the Jura and the Savoy Alps, with the chain of the Voirons and the Salève in close proximity to the south-east, it has only a restricted airspace for let-down and climb-out procedures. Only to the north-east is there freedom from obstacles, giving a broad cone of approach.

The effects of this topographical situation are various. For telecommunications it has been necessary to build a VHF relay station on the summit of the Dôle at an altitude of 1,680 metres (5,520 feet). This station is connected to the area control centre by a multi-channel 2,000 Mc/s microwave link. All broadcasts pass through this link: transmission and reception, orders and acknowledgements, radio bearings and also the VOLMET meteorological broadcasts covering nine western European airports.

The Collins VOR at Froideville marks the B4/UB4 and G5/UG5 airways and the turn-off point for jet aircraft wishing to land at Geneva.



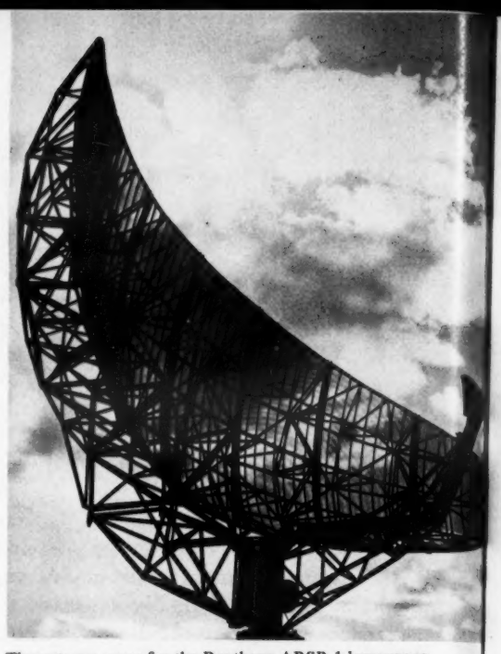
Thanks to the long range of the station these broadcasts are particularly appreciated by flight crews, and in keeping with the decision of ICAO, they will soon be made continuously.

A weather radar is also installed on the Dôle which gives the weather forecasters in Geneva a picture of the cloud formations. A surveillance radar is also in course of construction on the same site. This will give the Geneva control centre a coverage beyond the mountains of the order of 180 nautical miles. This mountain radar will complement the coverage of the two SRE radars which have just been brought into service on the airport and which are used by the approach control and area control. These have obviously a reduced range in the numerous directions where the mountains mask the horizon. Nevertheless they can "see" high-flying aircraft at an adequate distance. On the other hand, in the north-west sector, flights below 20,000 feet are taken into radar contact too late to be identified and controlled. This has made it necessary to install the radar station on the summit of the Jura. Thanks to these three radars the Geneva airport and area controls will have a very complete coverage, each installation being able, to a certain extent, to act as a reserve to the two others.

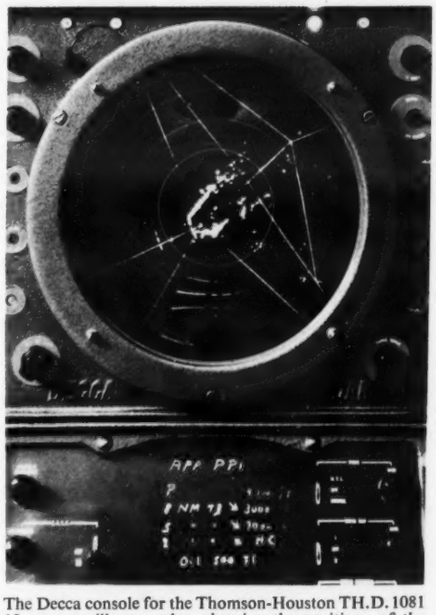
For the requirements of the control tower, the VHF transmitters and receivers are installed on the airport or in its immediate vicinity. This also applies to the HF station belonging to the centre, which provides a continuous service on four frequencies. The approach control is equipped with an automatic VHF/DF which operates on all the approach frequencies, and a precision approach radar. A modern ILS has replaced the old SCS 51 and the outer marker beacon has been installed on the edge of the lake. By means of a special aerial this indicates the position of the outer marker at a point above the water.

The Geneva centre is connected by direct telephone lines to the centres of Paris, Aix-en-Provence, Milan and Zurich and has duplex landlines for teletypewriter connection with the Swiss headquarters of the aeronautical fixed telecommunication network at Zurich.

As long as navigation aids have operated on the medium frequencies, the mountains surrounding Geneva have not presented any special problems. The introduction of omni-directional radio ranges working on very high frequencies has, however, presented many siting difficulties. It has been possible to install two so far; one ten kilometres (6 miles) to the south-west of Geneva (Passeiry) and the other 60 kilometres (36 miles) to the north-east (Froideville). For the third, which



The antenna array for the Raytheon ARSR 1 long-range 23-cm airways surveillance radar, to be set up next spring on the Dôle peak, spans 40 feet and will be protected from the weather by a plastic dome.



The Decca console for the Thomson-Houston TH.D. 1081 10-cm surveillance radar, showing the positions of the three airway beacons at Passeiry (lower left), Gland and Froideville (upper right), the airways leading to these, the blips of several aircraft and the mountain peaks of the Jura and Salève.

is to be the beacon necessary for the airways to Turin, Nice, Montélimar, Lyons, Autun, Dijon, and Luxeuil, a solution has not yet been found. To obtain the ranges required, an installation on the Jura appears to be the only answer. The trials carried out in the United States on Doppler-VOR will perhaps enable this requirement to be fulfilled.

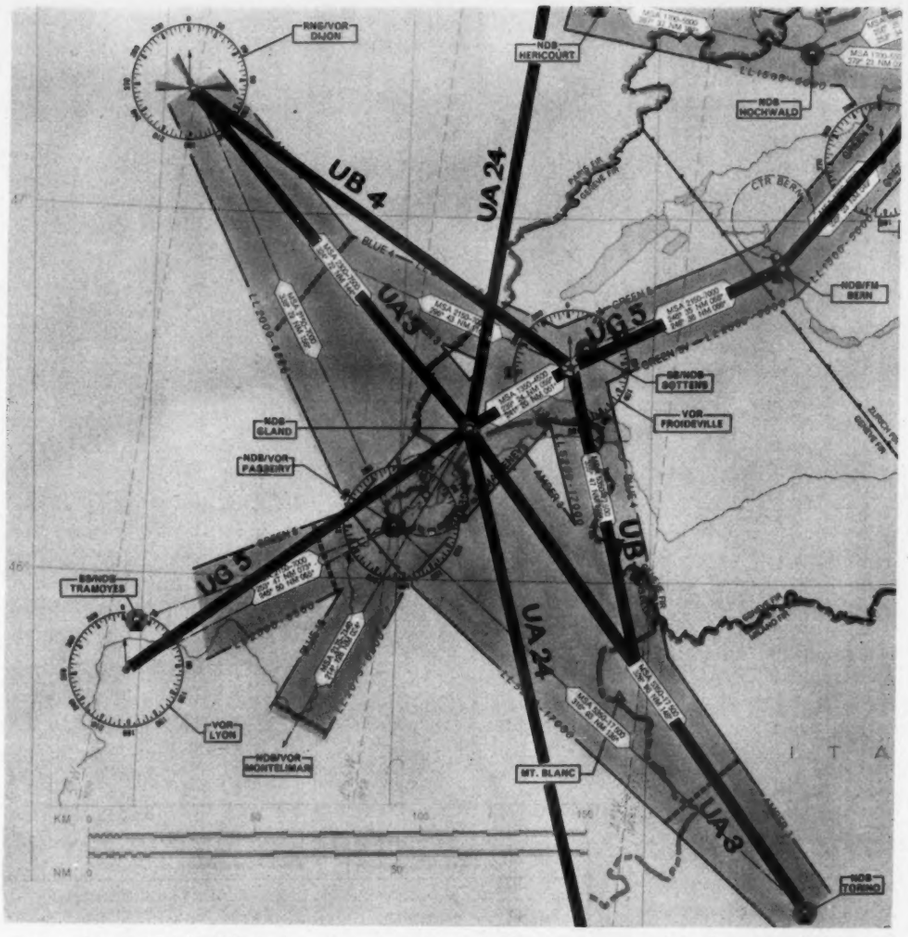
The topography of the surroundings of Geneva has had an effect both on the airport procedures and on the characteristics of the traffic in the area. The airway A3/UA3[2]

[2] A3 indicates the lower airway extending up to 20,000 feet, and UA3 the upper airway.

crosses the region and along this route flows a great part of the traffic going from north-western Europe towards Rome, the Middle and the Far East and vice versa. On this airway, the barrier of the Alps with Mont Blanc rising to 4,800 m (15,800 ft), necessitates increased safety altitudes. Another upper airway which crosses the Geneva area is the UA 24, recently opened to traffic, which enables aircraft coming from the north and particularly the Benelux countries, to reach Nice in almost a straight line. The airway G5/UG5 which crosses Switzerland from east to west is used by the majority of aircraft travelling from Germany to Spain and the Balearics. The airway B16 connects Geneva directly to Montélimar.

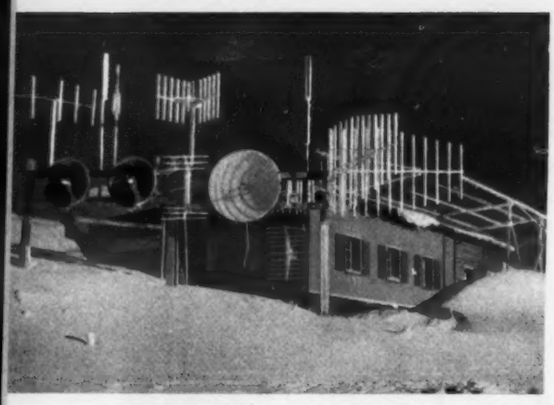
The traffic coming from seven directions, which passes the Gland radio beacon 20 km (12 miles) to the north-east of Geneva, amounts to some 220 to 250 movements per day. A hundred of these movements are to or from Geneva airport. The 120 to 150 aircraft in transit through the region are divided roughly into the following pattern: about 65% at high altitude and 35% at relatively low altitudes on the airway G5. The latter are mainly charter flights carried out in non-pressurized aircraft. The problem facing the area and approach controls is one of incorporating the arriving and departing aircraft in this heavy traffic flow. It is the same problem for all terminal areas, but here it is aggravated by the fact that the aircraft enter and leave at much higher altitudes than is the case in flat countries. In addition, the proximity of the Franco-Swiss frontier would render control of the airport traffic practically impossible if this had to be taken into account when fixing the limits of the Swiss control area. Since the introduction of the airways system to Europe, the French authorities have displayed great understanding by putting airspace which is essential to the control of Geneva airport traffic, at the disposal of Switzerland. A very close collaboration has been established between the Geneva centre and those of Paris and Aix-en-Provence.

Owing to the impossibility of establishing separate climb and descent paths in all directions, an entry and holding circuit to the north-east and a climb-out and departure circuit to the south-west, have been in existence for several years. The increase in traffic and the arrival on the scene of jet aircraft, demanding an increase in the available space for manoeuvre, have made it necessary to call upon the cooperation of the French authorities, to enable a separate arrival path from the airway A3/UA3 to be established. The opening of the airway B4/UB4 which



Section of the Federal Air Office's airways map for Switzerland The lower airways and the Geneva terminal area are shaded grey, the upper airways are shown in black; the lower limit of the lower airways is shown in metres above sea level (first figure) and in feet (second figure).

In the Geneva area control centre (ACC), controllers follow the progress of aircraft from reporting point to reporting point by means of conventional progress strips. Each controller has a visual D/F display in front of him. Behind the curtain is the radar cabin.



The Dôle VHF communications relay and automatic VHF D/F station, with the directional antenna reflectors for the radio links.

Antenna array for the Decca weather radar on the Dôle . . . in truly rural surroundings.

branches from the A3/UA3 at Dijon in the north-west and from Mont Blanc in the south-east, enables the Geneva traffic to be separated from the transit traffic. For the jets, this procedure makes a direct radar-controlled descent possible in the majority of cases. The control of the approach sequence by radar in a cone extending 60 km (36 miles) to the north-east and widening to about 40 km (24 miles), enables a reasonable traffic flow to be maintained to the airport, despite the presence of the mountains.

The climb-out procedures continue to be carried out to the south-east. As the Passeiry beacon has been complemented by a VOR, radar controlled diversionary routes can be utilized to accelerate the departures.

III. The outlook

Such are the special peculiarities of the Geneva area at the moment and for the immediate future. The solutions which may be found in a few years are difficult to foresee, as they depend on those which will be adopted on a world-wide basis, or at least on those in the Europe-Mediterranean region.

Much has been said on the topic of Eurocontrol, and there are many who see this centralization project as the remedy for all ills. I have already said that I do not believe in miracles and I feel it my duty to offer my own opinion on this scheme. I emphasize that I speak only for myself; the authorities of my country and the Editors of *Interavia* are perhaps of a diametrically opposite opinion. I apologize to all those who have planned this project, which in theory appears attractive, but to me the practical realization appears to be faced with almost insurmountable difficulties.

When one considers the means of communication which the central control must possess, the number of relay stations which must be erected at different points on the Continent and connected to the centre by a complex microwave or landline link, the equipment needed for the transmission of radar information coming from such a vast area, and the communications between all the control units and the dozens of terminal areas in the region, one remains sceptical. Furthermore, it must be realized that all this equipment must be completely reliable, for a breakdown at the centre, even of short duration, could paralyze all traffic and endanger safety. Can one really believe that for both the ground organization and for the pilots, control would be simplified by greater centralization while the procedures and navigation aids remain the same? I do not share this opinion because such a centralization would be a complete upheaval, and I think that any modifications to the present system should be made progressively, with each step being proven in turn.

Having said this, what can be done to simplify air traffic? For the control services the first step appears to me to be the establishment of a regional system of rapid communications between the existing centres. This would combine the transmission of information relative to each flight with the automatic preparation of the flight progress strips. Several varieties of this system are being evaluated throughout the world, and it is desirable that an agreement should be reached quickly on an international standard. The utilization of radar should be increased and its efficiency improved by the use of secondary radar. While waiting for the development of a high speed, automatic, air-ground communication system, a strenuous effort must be made to eliminate the large amount of useless speech which passes between the pilot and controller on the RT.

As regards the airline operators, I appreciate the difficulties involved but I wonder if the timetables could not be reviewed. How can one expect a smooth traffic flow when four or five arrivals and departures are listed for *the same minute* on one airport? Is not this an admission at the outset that the timings will not be maintained? Airport timetables are full of such cases.

Finally, it is to be hoped that the electronics engineers will soon provide us with a navigation aid giving area coverage, and of an order of accuracy which will enable air routes to be established like multi-lane motorways. It is also to be hoped that such a system will meet with universal support, without being tinged with commercial considerations.

One wish, to close with: that there may be a pause in the increase of aircraft performance in terms of speed but not in safety. Aviation needs to regain its breath. The airlines, the airport authorities, the pilots or the controllers, all need a period in which they can concentrate their attention on the improvement of what exists, without being haunted by what will be. ←

Technical equipment in the Geneva control centre: various VHF transmitters, magnetic tape recorders, the visual displays for the automatic VHF D/F system, etc.

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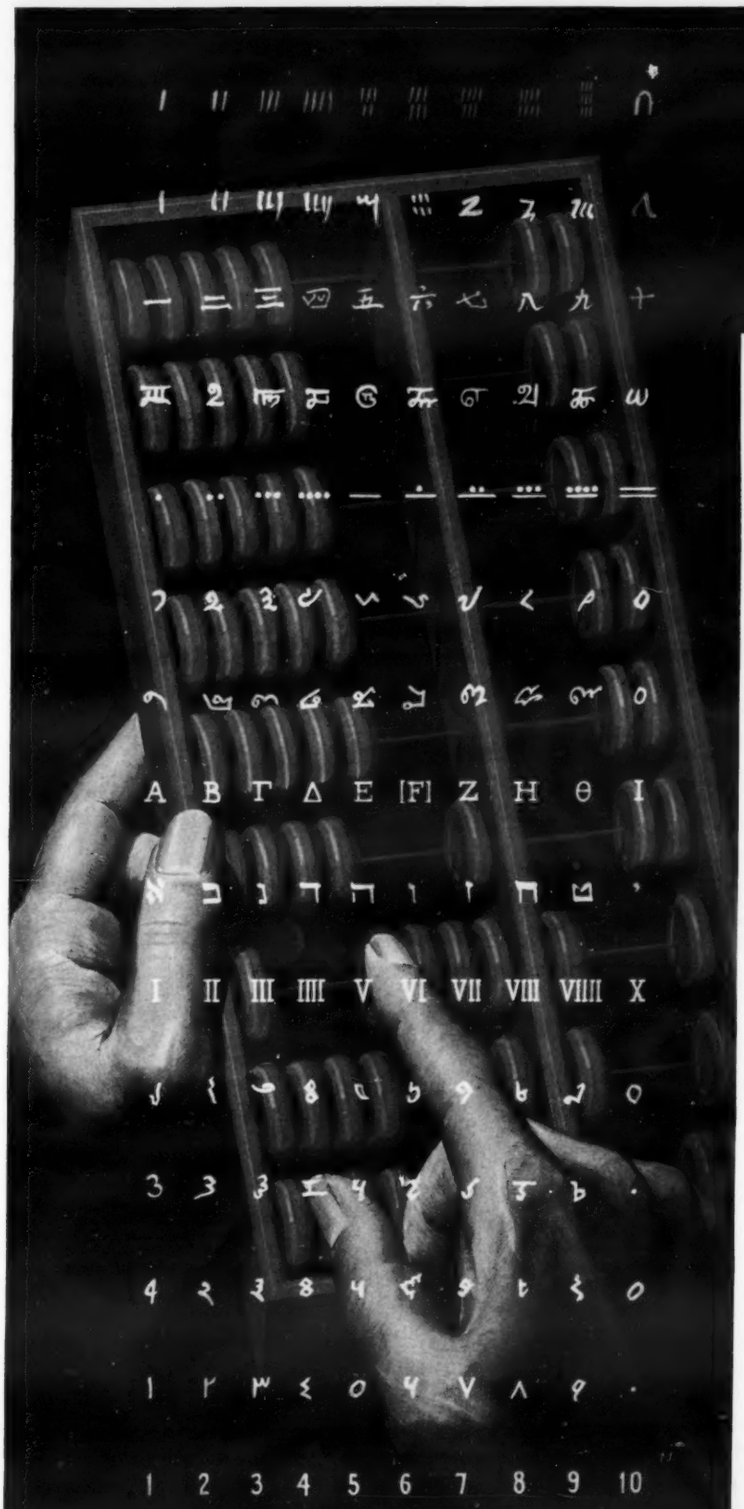

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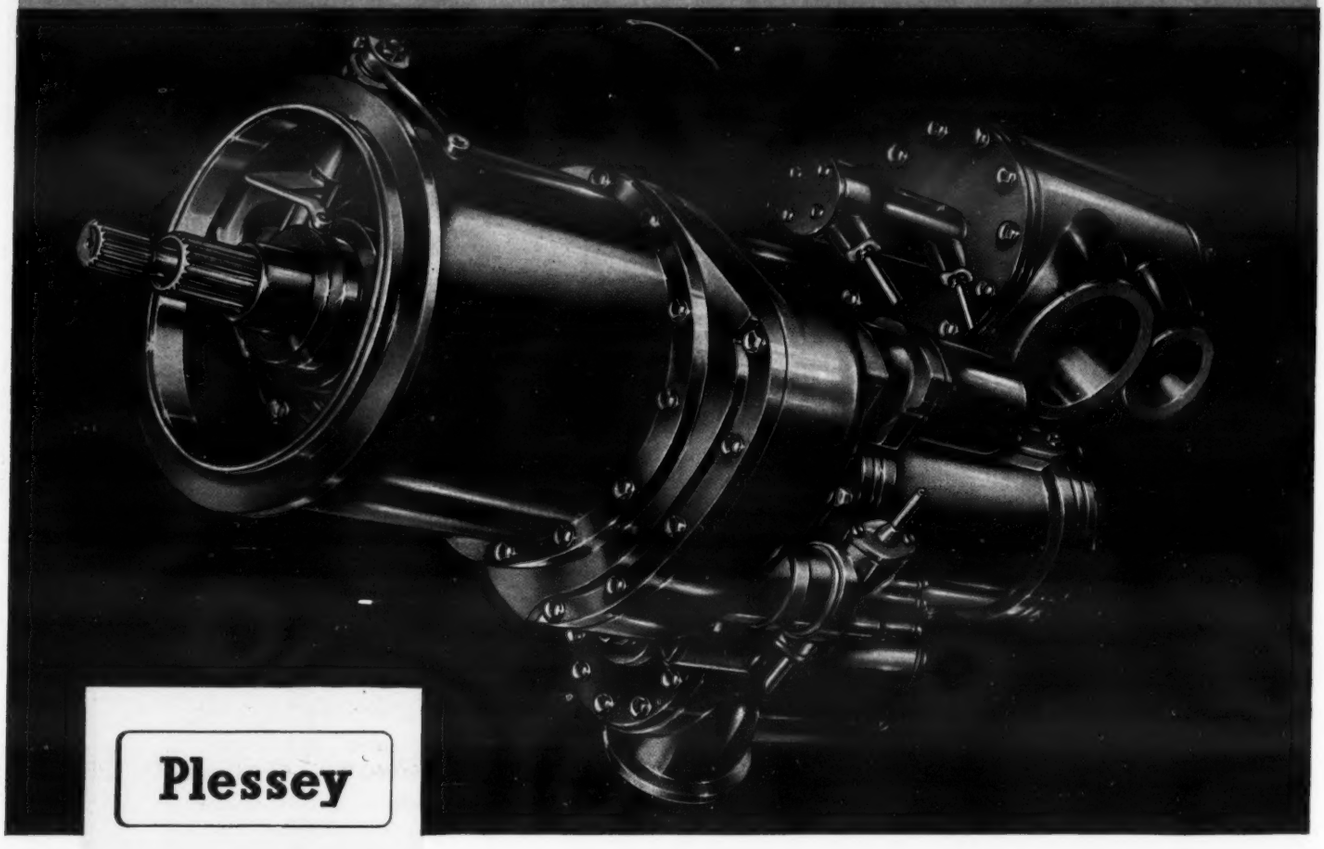

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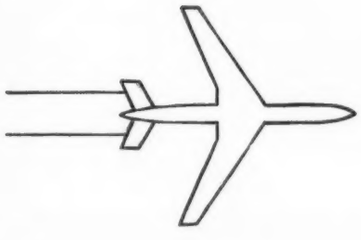

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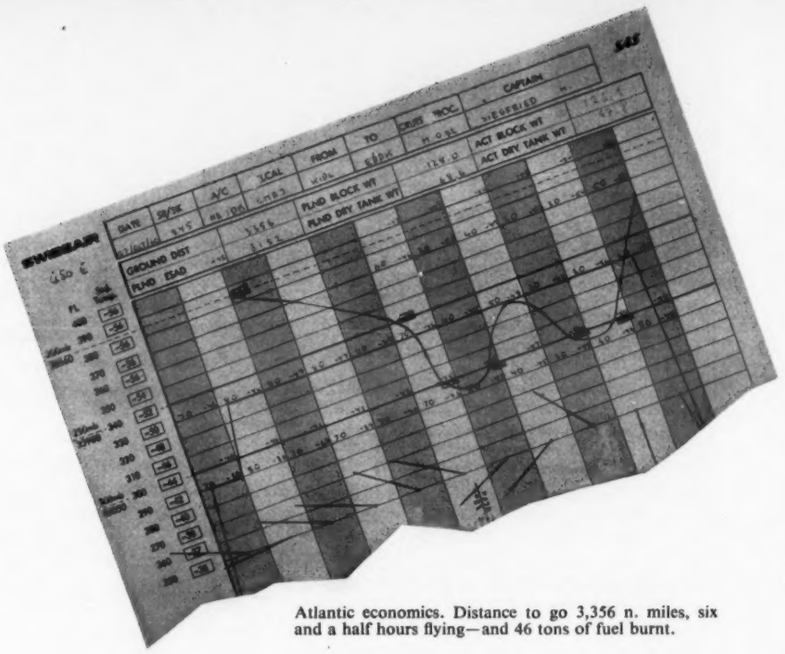


Atlantic economics. Distance to go 3,356 n. miles, six and a half hours flying—and 46 tons of fuel burnt.

By E. K. Barnes, Interavia, Geneva

The annual report of the International Air Transport Association for 1959 makes reference to new problems which have developed in navigation and air traffic control with the entry of the jet aircraft into commercial service.

Thanks to the assistance of the Swiss national carrier—Swissair—I was given the opportunity recently of obtaining a first-hand experience of these new complications. The route chosen for the demonstration was the one which is perhaps the most heavily populated by jet aircraft, namely the North Atlantic.

Before describing the trip itself, it is perhaps worthwhile to make some comments on the preceding twelve months' jet operations. During this period jet aircraft have been coming into service in steadily increasing numbers and have been sharing the air routes with piston-engined aircraft. The latter have been steadily withdrawn as the operating companies have introduced their new equipment into service.

The first point that becomes apparent is that these difficulties are not related to the aircraft as a machine. Reports from many sources indicate that in terms of serviceability the jet is far more trouble-free than its piston-engined predecessor. The main factor is the utilization of the jet profitably in today's traffic patterns.

To ensure this profitable utilization, the first requirement is that the aircraft should have unimpeded access to its cruising level, that it should be able to operate at the height which offers the minimum fuel consumption, and that it should be able to land with the minimum of delay at its destination.

It was to see the problems involved in achieving this ideal operation that I was invited to travel in the Swissair DC-8 "Jungfrau" from Zürich to New York and return.

Preparation for such a flight starts in the airline's dispatch office. As this all-important but little known department plays a vital part in the success of operations, a description of its function is essential.

The airline dispatch office can be described as the individual movement control centre for each airline. Within it is maintained a continuous progress check on the movements of all the companies' aircraft. All the aircraft movements are planned and coordinated from this centre, and company instructions passed to the aircraft captains on the routes.

The aircraft dispatchers manning this centre must combine the abilities of a movement control officer and a flight planner. In today's operations perhaps no single individual has such an influence on the economics of airline operations as the dispatcher.

In the case of the New York flight, planning started some six hours before take-off when the dispatcher assembled all the information concerning the flight and commenced preparation of the flight plan. The weight of the payload was calculated from the passenger list, and a route selected in relation to the latest weather information. During the hours preceding take-off this route would be revised if necessary in accordance with any last-minute information which came to hand. Eventually the flight plan was established and filed with air traffic control.

Two hours before take-off the final preparations for the flight commenced. Captain Siegfried and his crew reported to the weather bureau for the "met" briefing, and I listened to the forecaster describing conditions on the route and the landing forecasts for our intermediate stops. The flight was to be from Zürich to Lisbon, Lisbon to Santa Maria in the Azores for a refuelling stop and then direct to New York.

On this particular day, the weather presented no outstanding problems and the weather briefing was rapidly completed. The next stop was the dispatch office where the finalized flight plan awaited the captain's signature. Here the dispatcher explained the selected route, indicated the fuel load and selected route altitudes and listed the expected fuel consumptions for other altitudes if we were redirected by air traffic control.

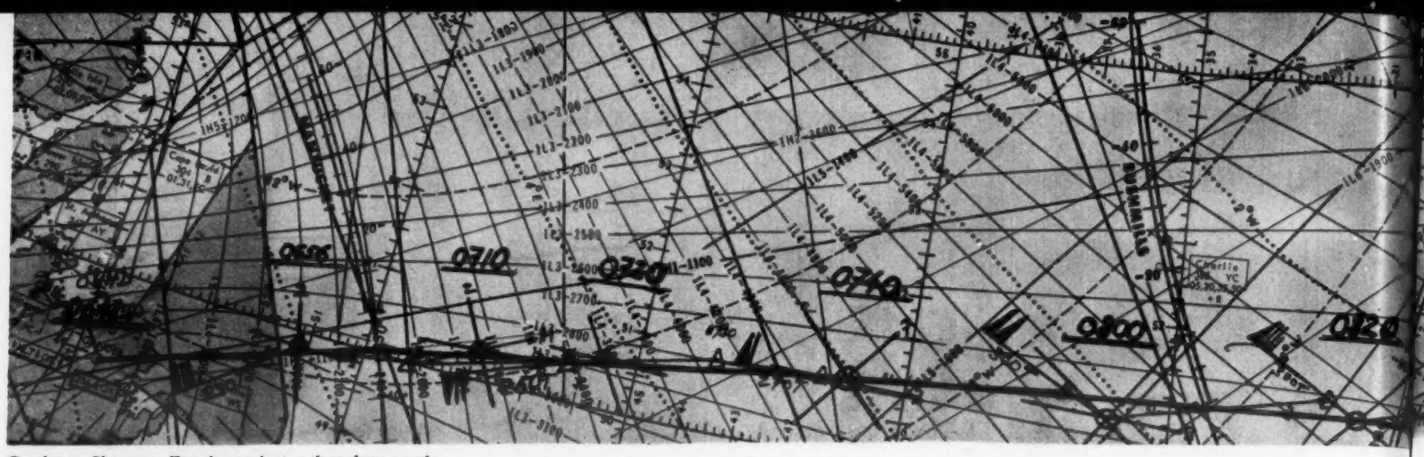
The flight plan as prepared in Zürich was primarily concerned with the leg Zürich–Lisbon. Although calculations had been made for the ocean crossing, these details were subject to change in the light of altered weather conditions, and the Swissair Lisbon dispatch office would provide the final plan for this section.

In terms of operation this particular route can be divided into two types. The first sector Zürich–Lisbon is flown on the upper airways, using ground-based navigation aids. During the ocean crossing Lisbon–Santa Maria–Idlewild it is the flight navigator who is responsible for position fixing and heading alteration.

After take-off from Zürich, the first thing that impressed me was the low noise level on the DC-8 flight deck. Conversation could be carried on in normal tones and I was able to hear the

Flight deck scene at Mach 0.82. The copilot transmits a position report.

Dispatch briefing. The captain and crew listen to the dispatcher as the flight plan is examined.



Gander to Shannon. For the navigator three hours and sixteen minutes of continuous calculations. The chart shows the positions as plotted every twenty minutes, with the wind speeds and directions derived from the pressure pattern every ten minutes.

VHF transmissions made by the pilots as each reporting point was reached.

Although the number of reporting points between Zürich and Lisbon is not excessive, one detail came to light very rapidly. In an aircraft covering the ground at approximately ten miles per minute, the time available for each report is brief. Waiting for a suitable lull in the communications in order to make a report often results in the point being overflown and passed by some considerable distance before the report can be made. For the pilots therefore the problem of reporting progress to the traffic centres en route is one which demands continuous anticipation. Much has been said and written about automated communications systems; listening to the routine communications from the flight deck of a jet aircraft is a convincing demonstration that the human voice is too slow a medium for the transmission of information at jet speeds.

At the present moment, the trans-Atlantic service via Lisbon is faced with operational difficulties. The Lisbon runway in use at present is too short for an Atlantic-bound jet to take off with a fuel load sufficient for the ocean crossing. A technical stop is made therefore at Santa Maria for refuelling. The sector Lisbon—Idlewild can however be considered as one unit for the purposes of navigation.

Prior to leaving Zürich, the navigator Mr. Reber had explained that his responsibilities really commenced from Lisbon onwards. During the Zürich–Lisbon flight he only needed to keep a watch on progress, but during the ocean crossing he would be fully occupied. Once we left the European coast I realized the wealth of understatement in the phrase "fully occupied."

Before giving any detailed account of the ocean crossing, a few words should be said on oceanic control systems. For high altitude jet operations air traffic control regulations specify a vertical separation between aircraft of two thousand feet. In practice this means that the flight levels of 28, 31, 35 and 39,000 feet are available to westbound aircraft, while eastbound traffic operates at 29, 33, 37 and 41,000 feet.

At the same time, aircraft must maintain a longitudinal separation of 200 nautical miles or 30 minutes' flying time, and a lateral separation of 2° or 60 nautical miles on each side of track. In effect this means that the aircraft crosses the Atlantic, carrying with it a block of airspace 200 miles long and 120 miles wide at a certain level. This flight level is then denied to any succeeding aircraft for a minimum of 30 minutes.

The responsibility for ensuring that the aircraft maintains its planned route and remains within these limits falls to the navigator. On board "Jungfrau," three navigational methods were employed to ensure this route fixing and checking. These three methods were astro navigation, Loran and pressure pattern navigation.

The latter system provides the crew with the wind conditions prevailing on the route and supplies the heading corrections necessary both to correct for drift and also to make the most use of prevailing winds.

The principles of pressure pattern navigation are easily understood. The aircraft is flown at a constant height as indicated by the pressure altimeter. In effect this means that the aircraft is flying at a constant pressure level but that its absolute altitude in terms of distance from the earth's surface is varying in relation to the changes of atmospheric pressure.

To compare these two values two altimeters are used. The first is used to maintain the aircraft at a chosen pressure altitude while the second, the radio altimeter, measures the true altitude of the aircraft above the earth's surface. It is obvious that the most satisfactory routes for pressure pattern navigation are ocean crossings, as it is not too practical to determine the difference between absolute and pressure altitudes when flying over land.

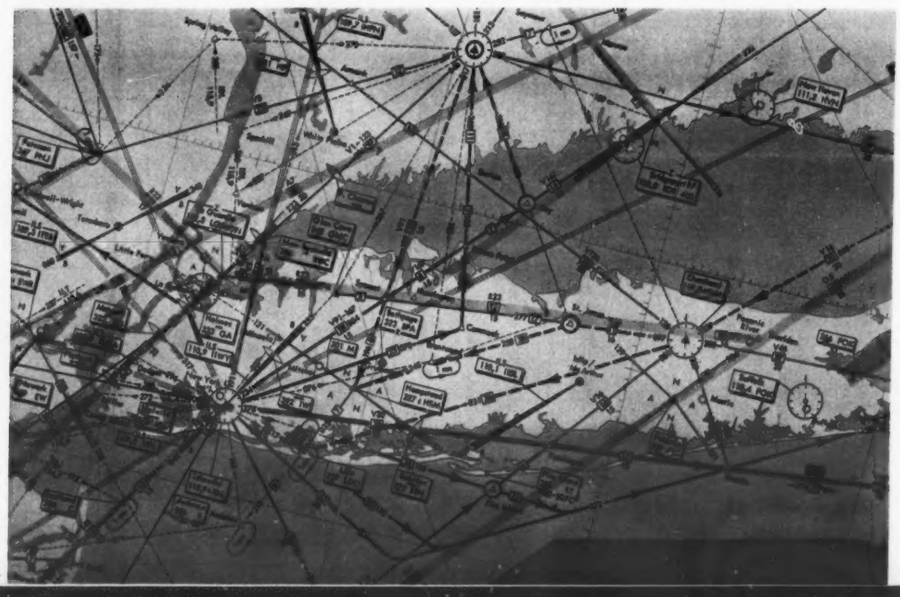
For the navigator on this journey, the maintenance of a pressure navigation plot entailed taking the readings from the radio altimeter every ten minutes and working out the drift and wind component. At first glance a ten minute frequency in readings does not appear too onerous, but he is still faced with the problem of taking astro or sunshots and Loran readings in the intervals.

An aircraft flying at a constant pressure altitude is actually flying at a constant barometric pressure. As the radio altimeter is measuring the absolute altitude over the surface, the difference between the absolute and the pressure values indicates the slope of the isobaric surface. The degree of this slope can be converted into terms of crosswind component and drift angle. When the difference between the readings indicates that the aircraft is heading into a region of low pressure, this means that in the Northern hemisphere the wind is from the left and the aircraft obviously drifts to the right. When the aircraft is heading towards a high pressure area the effects are, of course, reversed.*

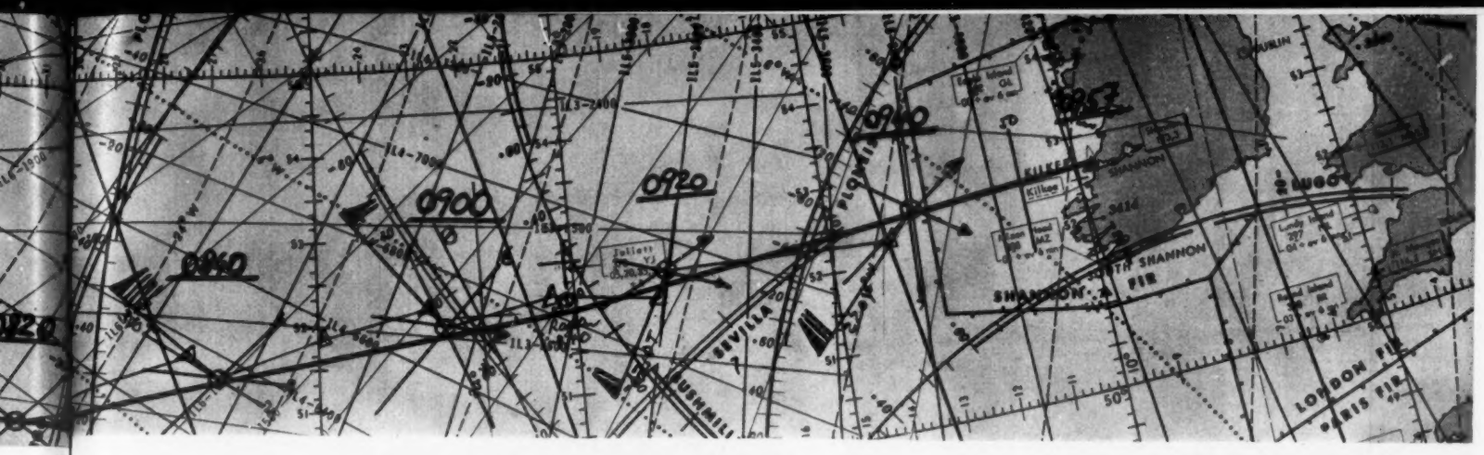
For the navigator on an oceanic flight the journey represents a period of continuous calculation. The first and most obvious effect of jet cruising speeds is that navigation is no longer a science of determining one's present position but is becoming a record of where one was some hundred miles previously.

A further effect which stems from the present separation regulations is that the navigator is greatly restricted in taking any advantage of meteorological conditions which develop in mid-ocean. As the aircraft's flight level has been determined prior to take-off on a basis of information available at the point of departure and also in relation to other traffic on the route, it is not possible to make changes in route altitude to meet wind conditions encountered during the crossing.

This maze of routes leading into and out of New York International Airport illustrates the difficulties facing the jet aircraft captain. After completing the Atlantic crossing, the aircraft must be integrated into the pattern of traffic circulating on these various airways, and brought down to circuit height at Idlewild with the minimum of delay.



* "The Basic Principles of Pressure Pattern Navigation," by W. Partl, in *Interavia* No. 8, 1960, p. 986.



As a result one can only observe that the full potential of the jet aircraft cannot be exploited owing to the present inflexibility of the air traffic system. This statement does not infer a criticism of the traffic system as such. The problem is one of finding better methods to enable the available potential to be developed.

The two stages from Lisbon to New York can be described briefly. After take-off from Lisbon in a gusty cross wind, the navigator settled down to the feverish routine of calculation which would continue until we made our landfall on the other side of the Atlantic. A hundred miles away from Santa Maria it was possible to pinpoint the pattern of islands on the radar. A reporting call was made to Santa Maria control and we were cleared into the area and handed over to approach control. Here the weather conditions were kinder to us than those in Lisbon. A steady 10 knot wind was blowing directly down the runway and "Jungfrau" came in to an impeccable touchdown. After 45 minutes on the ground the refuelling was completed and the passengers re-embarked. The crew made a last check on the weather in the "met" office and the final flight plan was filed.

After take-off from Santa Maria, heavily laden with fuel, the aircraft climbed rapidly to the selected flight level of 31,000 feet. The navigator drew the light screens around his desk to enable him to read the flickering traces on the face of the Loran screen and the radio altimeter, and the crew settled down to the routine for the ocean crossing.

For each man on the flight deck this routine differs. For the flight engineer it consists of a constant watch on the engine instruments and fuel flow gauges. Every half hour the log book has to be completed and the fuel state calculated and passed to the captain.

For the two pilots it consists of a constant monitoring of the flight instruments and a listening watch on the radio. From time to time a chit is passed forward from the navigator calling for a change of heading, as position fixes indicate a deviation from the desired track. One point at least strikes the onlooker forcibly. That is the silence. Little is said between the crew apart from an occasional question and answer, and each man remains immersed in his own responsibilities. The silence above all emphasizes the concentration which these large aircraft demand throughout every moment of the flight.

As the flight progressed I could see the successive position fixes moving steadily across the chart. Outside, a layer of broken cloud obscured the sea, but above was a clear sky. For the navigator at least this was an advantage as he was able to make his sun observations without difficulty. Despite the often quoted idea of flying over the weather, there are many occasions when cloud layers extend above the aircraft's cruising level, rendering astro navigation impossible.

As the American coast was neared, the radar was switched on and eventually the outline of the coast appeared on the edge of the screen. The navigator at least was able to relax from a concentrated six hours of calculations and position fixing. The New York control was contacted on the VHF and the last stage of the flight began. In many respects this is the most complicated part of the journey, as the aircraft has to be threaded through the mass of international and domestic traffic operating in the New York area. Once again there arose the difficulties of immediate communication with the control centre, but after carrying out two procedure turns to identify the aircraft on the ground radar, we were accepted into the Idlewild traffic pattern for landing.

In retrospect, two impressions remain outstanding. The first has already been commented upon and concerns the concentration demanded of the crew during such a flight. It is illustrative to report that, with the exception of the navigator who was compelled to move about the flight deck to take astro shots, no member of the crew moved from his seat during the whole time we were airborne on either the outward or return journey. In itself this may appear a small point, but the prospect of being strapped in a seat for a period of six hours is daunting. Despite the reduced flying times in jets, the question of crew fatigue is of major importance.

The second impression can be summed up as a realization that there is insufficient airspace. In relation to the immensity of the Atlantic this may appear ridiculous at first glance. Consideration should be given to a number of factors. For a flight between a major European airport and New York it is obvious that the dispatchers of the various operating companies will endeavour to secure the most favourable flight altitudes for their aircraft to take advantage of existing weather and operating conditions.

At the same time the schedules of the operating companies tend to follow a similar pattern so as to enable the passengers to arrive at the destination at a convenient hour either to join connecting flights or to obtain hotel accommodation.

With four available flight levels and a delay of half an hour between aircraft operating on the same level, it becomes obvious that many flights will have to be carried out at altitudes which do not offer the best operating conditions. This results in both increased fuel consumption and increased flight times.

The effect of these difficulties on the economics of airline operation is best illustrated by the case of a jet aircraft already airborne which was assigned a flight level entailing the consumption of an extra 5,000 pounds of fuel. In order to take this extra fuel on board for the ocean crossing, 15,000 pounds had to be dumped to reduce the weight to the aircraft's maximum landing weight. The aircraft then landed, loaded a total of 20,000 pounds and took off again for the crossing.

To reduce the difficulties which arise from such a crowded airspace, the first requirement is a navigation system which offers a greater accuracy in position fixing and position reporting. When such a system comes into general operation it will then be possible to reduce the existing separation minima.

The use of Doppler radar was discussed at length during the 13th IATA Technical Conference. This aid would provide a continuous record of distance flown, drift angle and distance off track. Such an aid in conjunction with a precision altimeter system would enable air traffic control to feed aircraft on to the routes at a higher density and frequency and would also enable the aircraft to be routed at more favourable altitudes.

Apart from the economies to be achieved in operation through more accurate track keeping and shorter flight times, there are other reasons why the companies would prefer to adopt an airborne navigation aid. By being independent of ground-based facilities there are savings to be made in landing and operating charges. When faced with the cost of satisfying the voracious thirst of the jet engine, any means of reducing overhead costs are of interest to ensure the profitability of jet operation.

In the landing pattern the same factors apply. The use of secondary radar to ensure positive aircraft identification on entering a control zone will obviate the necessity of flying specific patterns which can be identified on the ground radar display. Again this would result in reduced flying time and operating costs.

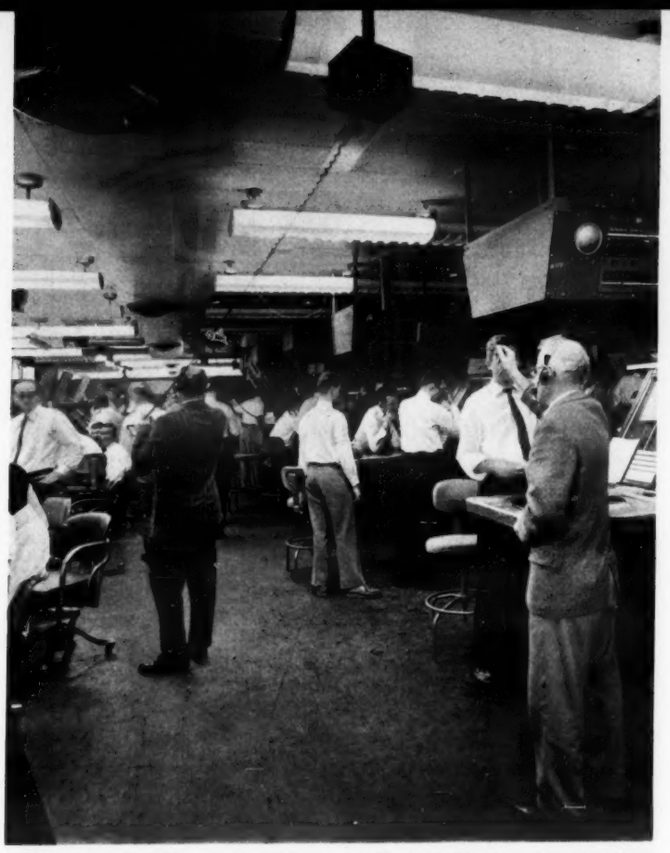
On reflection it becomes apparent that the difficulties of jet operation today are in fact teething troubles. The present operating regulations are based upon liberal safety considerations, and this is of primary importance in the steady growth of air transport.

Perhaps it is safe to say that at the moment it is the passenger who derives the greatest benefit from jet transport. From the operating viewpoint the jet is only at the threshold of its profitable career. At the moment its speed and capabilities have outstripped the techniques which have been developed for a slower traffic pattern. When the traffic regulation facilities have been geared up to enable it to develop its full economic possibilities, it will then be time to say that the Jet Age has arrived. ←

Flight Plan – Clearance – Separation

The Work of the Air Traffic Controller

By D. Ebert, Interavia, Geneva



Inside a busy air traffic control centre: the Air Route Traffic Control at New York International.

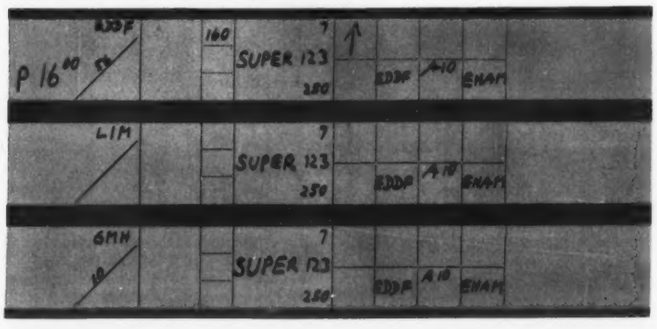
For many years air traffic control was the Cinderella of aviation, and it is only recently that it has gained a certain amount of publicity —on the one hand because of a series of accidents which probably would not have occurred if the control system had been expanded in time, and on the other from reports on new radar equipments, navigation systems and electronic computers for future use in air traffic control. But so far little has been written about the actual work of the traffic controllers throughout the world who daily bear the heavy responsibility for the lives of thousands of passengers and for the safety of aircraft worth millions of dollars. The following article, therefore, is devoted to the activities of this oft-maligned official. Names such as Frankfurt, Rome, Amsterdam, etc. have been chosen at random; however, though each airport has its own local peculiarities, air traffic control is effected on the same principles all over the world.

Let us therefore immediately pass behind the scenes and see how an aircraft is filtered through the dense traffic.

"*Super one two three*, a DC seven, filed true airspeed two five zero knots, proposing (take-off) at one six zero zero, estimated time en route five six minutes, requested flight level one six zero, Frankfurt via airways amber one zero to Amsterdam.*"

* One method of forming an aircraft call-sign is to use the abbreviated name of the airline plus the number of the flight. The aircraft in question here is Flight No. 123 of (fictitious) Super Airways.

Flight progress strips for a departure (explanation in text).



These are the details which the traffic office—where the pilot has just deposited his flight plan—passes to the area control centre. A selection of these data is also transmitted to the aerodrome control tower and the approach control office—in English of course, as this is the international language of aviation.

In the area control centre the flight plan details are immediately recorded on a flight progress strip; these strips are yellow for eastbound flights, blue for westbound flights. Another strip is prepared for each fix point (or reporting point) over which *Super 123* must fly in the control area. Times and flight levels are not entered until the pilot has received his clearance, when *Super 123* becomes part of the "active traffic." For the time being, only the proposed time of departure (P 1600) and the flight level requested by the pilot (FL 160 is a flight level of approximately 16,000 feet) are entered on the strip.

The three strips are then taken to the controller who will be responsible for issuing the clearance for this particular flight.

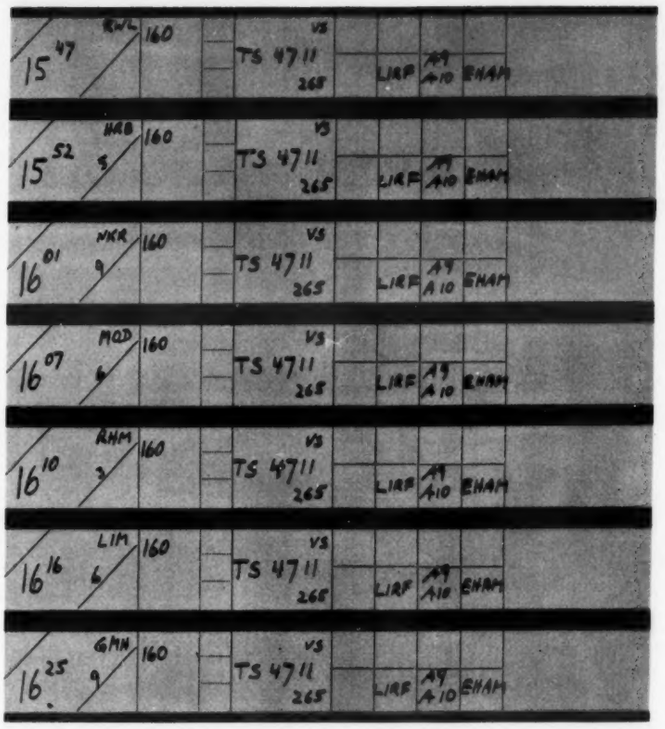
At airports with slight or moderate traffic, the controller responsible for the appropriate sector will often issue clearances for departure. But where traffic volume is so heavy that at peak periods the sector controller must concentrate all his attention and his skill on keeping abreast of the rapidly changing traffic picture, a second controller will issue en route clearances for departing aircraft—and will have his hands full. It may happen, for example, that at the same time as the flight plan for *Super 123* is received, one of the adjacent control centres passes a flight plan for an aircraft which is already en route and for which an estimated time of arrival over the first reporting point in the controller's own area can be given:

"*Tango Sierra four seven one one, Viscount, true airspeed two six five knots, estimated over Rottweil at one five four seven, flight level one six zero, Rome via airway amber nine and amber one zero to Amsterdam.*" "Tango" and "Sierra" are the names for the letters T and S in the international aviation alphabet. Estimated times over reporting

points are calculated from the aircraft's true airspeed, distances and upper air winds; for the distance of 25 nautical miles between RWL and HRB for example, a *Viscount* flying at a speed of 265 knots with 20-knot tail wind takes only 5 minutes. Whereas the aircraft's altimeter is set to the local pressure (QNH) for take-off and landing, the standard setting of 1,013.2 millibars is used en route, and the aircraft flies not at a given *altitude* but at a given *flight level*.

For this flight, too, a progress strip must be made out for each reporting point, making a total of seven strips. In some cases (e.g., training flights) twenty or more strips must be "penned" for a single aircraft. In Germany alone, for instance, some three million strips are written out each year—still by hand, just as was done ten or fifteen years ago. Incredible as it may sound, this is still the safest and best method of presenting the three-dimensional traffic situation in the airspace. Even the promised future semi-automatic control systems will not be able to dispense entirely with flight progress strips . . .

The seven strips are arranged in chronological order among the other strips already made out for each reporting point (RWL, HRB, etc.). The controller, who is in direct voice contact with the pilot, must now create for himself his own three-dimensional mental picture of the positions and movements of the aircraft under his charge, from the information contained on perhaps 50 or more strips for each reporting point in his sector.



Progress strips for an overflight (explanation in text).

The individual strips are placed in holders which slide up and down on two guide rods in the bays of the flight progress board. In this way, strips can easily be exchanged or altered in sequence. Entries are, left to right: 46 = pilot's estimated time over reporting point (in minutes, i. e., 1546 hours). 1547 = reporting time estimated by controller. 44 = actual time over reporting point. RWL = identification of beacon or reporting point. 160 = flight level. TS 4711 = call-sign of aircraft. VS = Viscount. 265 = true airspeed in knots. LIRF = airport of departure (here Rome-Fiumicino; each airport is known by an abbreviation consisting of four letters). A9, A10 = airway amber 9 and airway amber 10. EHAM = abbreviation for airport of destination (Amsterdam).

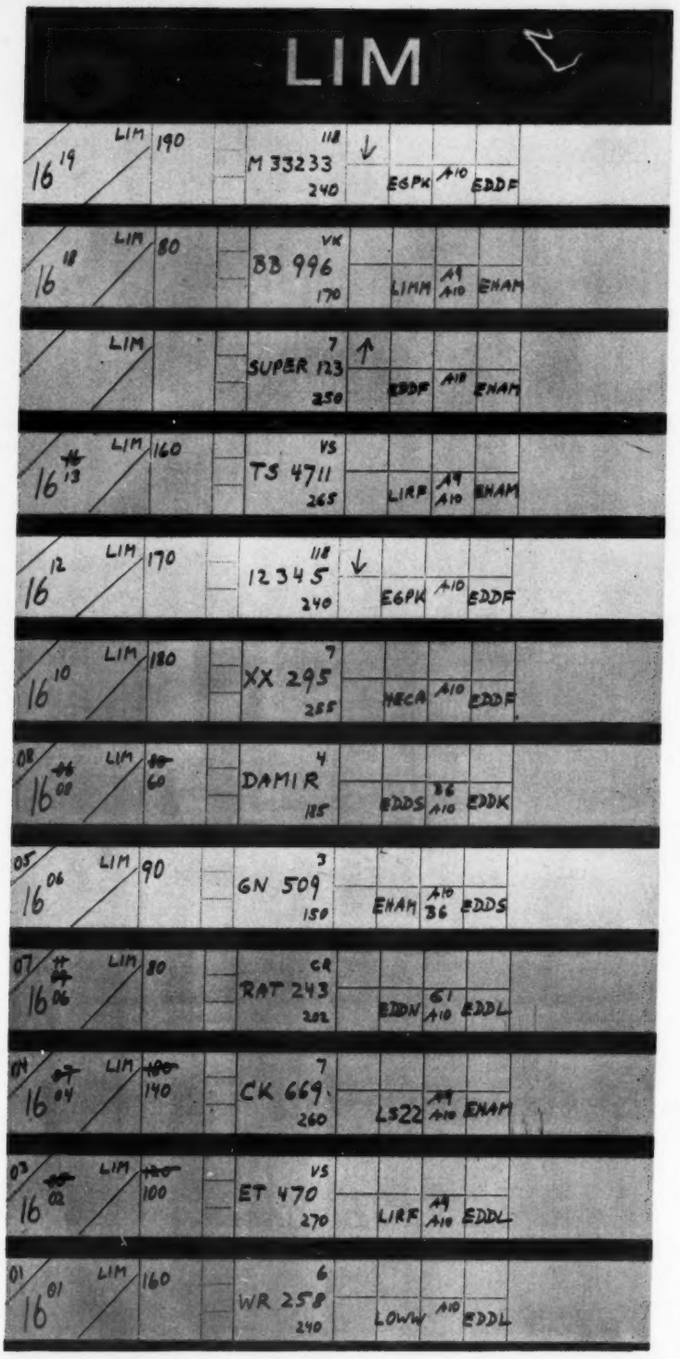
Progress strips, headphones, microphone and ball point are the "tools" of the air traffic controller, who must generally work in a darkened room as the radar screens would be impossible to read in broad daylight.

The most modern control centre in the world (Oakland Center at Fremont, Calif.) was opened just a few weeks ago. Control room and desks for the controllers are installed in a separate building, on the very latest principles. By the autumn of 1962 a total of 24 centres of this type are to be built in the United States.

But now *TS 4711*—the pilot of this *Viscount* had reported on the frequency of our control centre before crossing over into the area—gives his position report over Rottweil:

"*TS 4711, over Rottweil at 44, flight level 160, estimating Herrenberg at 50.*" (Where there is no likelihood of confusion, times are given only in minutes.)

His early arrival may be due to the upper air winds, which can never be forecast with absolute reliability: *TS 4711* is three minutes ahead of his estimated time entered on the Rottweil strip (RWL). This, of course, must immediately be allowed for on all the other strips, as the controller must base his picture of the traffic situation on these times. The other sectors in the area and the adjacent centres must also be notified. Revisions of this kind are extremely important, for neglect to notify corrections—even if only three minutes are involved—may lead to dangerous conflicts, since in many cases longitudinal separation between two aircraft on the same flight level may be only five minutes.


LIM
16 19 LIM 190 M 33233 240 EGPK A10 EDDF
16 18 LIM 80 BB 996 170 LIMM A9 A10 EHAM
LIM SUPER 123 250 EDDF A10 EHAM
16 13 LIM 160 TS 4711 265 LIRF A9 A10 EHAM
16 12 LIM 170 12345 240 EGPK A10 EDDF
16 10 LIM 180 XX 295 285 HECA A10 EDDF
16 00 LIM 60 DAMIR 115 EDDS A10 EDDK
16 06 LIM 90 GN 509 150 EHAM A10 EDDS
16 06 LIM 80 RAT 243 EDDN A10 EDDL
16 04 LIM 140 CK 669 260 LS22 A10 EHAM
16 02 LIM 100 ET 470 270 LIRF A9 A10 EDDL
16 01 LIM 160 WR 258 240 LOWW A10 EDDL

Picture of the traffic situation in the airspace over reporting point LIM (explanation in text).

Meanwhile it is time to turn our attention to *Super 123*. The pilot has started his engines and received his taxi clearance from the tower: "*Super 123 cleared to runway 25, wind 230 degrees, 12 knots, QNH 1009 millibars.*"

What in the controlled airspace applies only to IFR flights, must at an airport also be applied to all aircraft, vehicles and even pedestrians on the surface: no movement without clearance from the appropriate control centre.

At the same time as it issues the taxi clearance, the tower asks the centre for en route clearance for *Super 123*. Let us now try to follow the thoughts of the departure controller who must "hatch out" the requested clearance.

The traffic situation in the area of *Super 123's* first reporting point (LIM) is presented by the data on the progress strips for LIM. The question now is: how can *Super 123* be fitted into the existing traffic? A glance at the clock: it is 1554. The controller knows by experience that a DC-7 needs about ten minutes for take-off and another nine minutes to climb to the first beacon. This gives a provisional estimate for LIM of 1614. To make things easier, the controller arranges the strip for *Super 123* among the other strips in what he estimates will be the correct chronological order.

The pilot had asked for flight level 160. But this level is already occupied by flight *TS 4711*, which will be over LIM shortly before *Super 123*. FL 160 is therefore "no go." FL 180 is no better, since this is already taken by aircraft *XX 295*. What about FL 140? The controller knits his brow: *CK 669* will be over LIM at 1604 hours at flight level 140. As *Super 123* will be over LIM at least ten minutes later, i.e., not earlier than 1614 hours, it would just do, since there must be a ten-minute separation between these two flights. To be on the safe side, a quick call to the adjacent sector: is *CK 669* on time? Answer: yes, perhaps even one minute early. All the better, then *Super 123* can have flight level 140—but the controller must still remember to keep an eye on *CK 669*. Because of the many uncertainties which can completely alter the traffic situation and often necessitate rapid drastic changes in planning, air traffic controllers have a saying that a hundred percent safe is not good enough, better make it a hundred and fifty percent!

Now comes the next question: how to get *Super 123* up to cruising flight level 140. There are already five other aircraft flying at lower levels: GN 509 in the opposite direction at FL 90 (LIM at 1606), DAMIR in the same direction at FL 60 (LIM at 1608), RAT 243 at FL 80 (LIM at 1606), BB 996 also at FL 80 (LIM at 1618) and ET 470 at FL 100 (LIM at 1602). Therefore *Super 123* certainly cannot climb directly on course to FL 140, because that would give it insufficient separation from the other five aircraft.

What's the answer? One way would be to have *Super 123* climb on a detour, so that it does not enter airway A 10 (A = amber). But that would be a time-consuming procedure. Besides, where is there room for it in the terminal control area in dense traffic? The other detours known to the controller are at least as time-wasting, cumbersome and uneconomic.

This is where radar comes to the aid. If aircraft movements are watched on the radar screen, longitudinal separation (nearly 50 miles for a DC-7) can be reduced to some 6 miles.

Of course, the radar controller must also be familiar with the traffic and know from what other aircraft he must keep *Super 123* away. For him, however, it is no longer any great problem to get this aircraft safely and without major delays onto its cruising flight level.

One more point, however: when examining the flight progress strips for LIM, the departure controller has noticed that though, according to the estimated times over the reporting point, there is a 12-minute separation between WR 258 and TS 4711—both flying at FL 160—TS 4711 is 25 knots faster than WR 258 and is therefore gradually catching up on him. The sector controller has long since recognized the problem and has agreed with his colleague in the adjacent centre that WR 258 shall descend to FL 150 after passing LIM. Admittedly the odd flight levels on this airway are normally reserved for south-bound flights, but exceptions to standard procedures can always be made by agreement between the two centres.

And now *Super 123* gets his clearance as follows: "*Super 123 is cleared to the Amsterdam airport, maintain flight level 140, climb on a track of 220 to 4,000 feet, expect further climb instructions after take-off from Frankfurt radar on frequency 128.0.*"

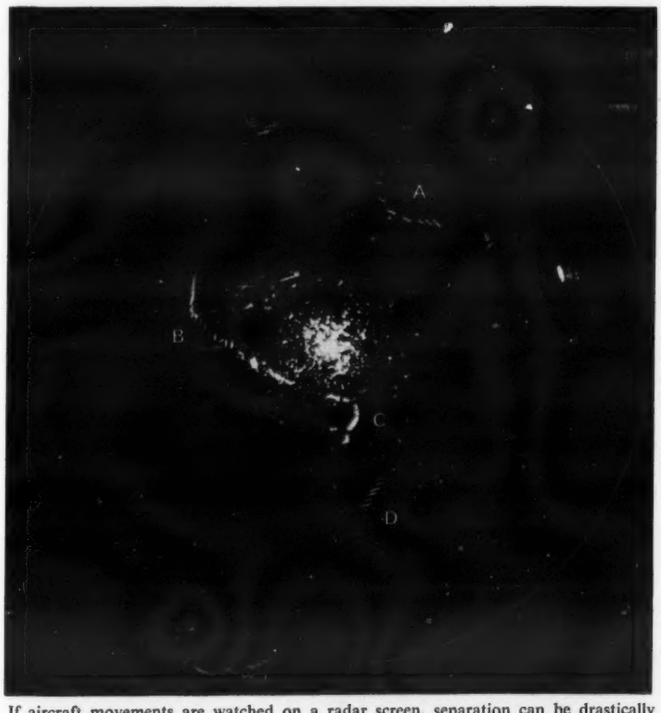
This is a very simple clearance, as the pilot will get all further instructions from the radar controller during his climb. Matters are much more difficult when there is no radar. The following is an example of a somewhat more complicated clearance: "*. . . is cleared to . . . airport via ABC, DEF, GHI and airways . . ., maintain flight level 140. Right turn after take-off, climb on a track of 335 to 3,000 feet, turn left and climb to flight level 50 homing on ABC. After passing ABC turn left and climb on radial 270 to FL 80. Upon reaching FL 80 turn left again and home on DEF maintaining FL 80. After passing DEF proceed to GHI climbing to FL 120, thence continue climb to FL 140 on course. Clearance expires at 1603.*" This clearance must not only

be followed by the pilot to the letter; it had first to be worked out by the controller on the basis of the existing traffic situation.

But back to *Super 123*. With his taxi clearance, the pilot has taxied to the holding position by runway 25, made his engine run-up and carried out a whole series of checks to make sure that all his instruments and systems are functioning reliably. He then reports to the tower, "ready for take-off." As soon as the runway is clear, and there is no other aircraft in the final approach, the controller in the tower gives the pilot his take-off clearance.

Shortly afterwards, the pilot calls approach control, which despite its name also controls departures. The amount of airspace around the airport which comes under approach control's charge varies from case to case, being in fact that portion of the airspace occupied by the arriving and departing aircraft for which it is responsible. By means of additional instructions, which must of course be coordinated with the area control centre, approach control will now guide *Super 123* in such a way that adequate separation from all other aircraft is ensured. Here again, the use of radar is of great assistance and helps to avoid otherwise unavoidable delays and detours.

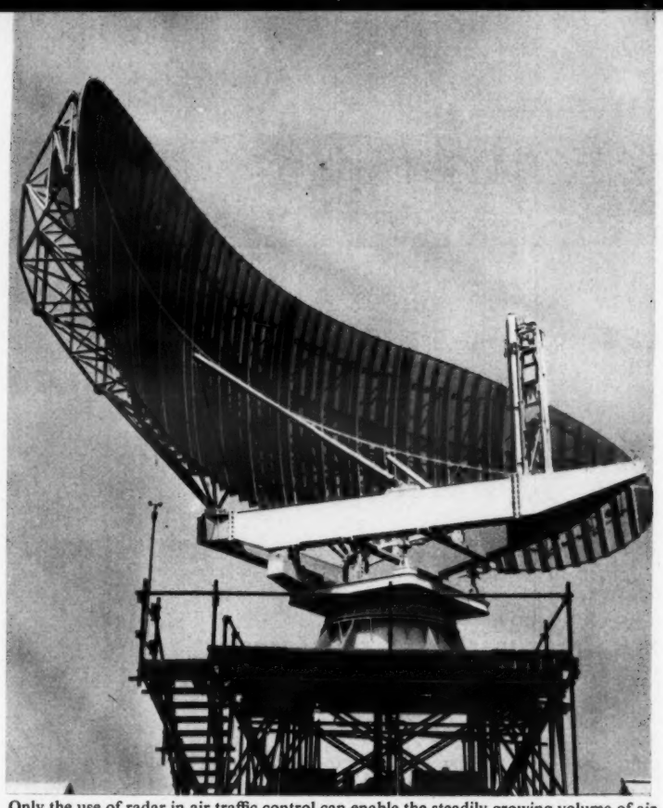
As soon as *Super 123* is sufficiently separated from the other aircraft under approach control, the flight is passed on to the area control centre, or in the present example to the radar controller there. The



If aircraft movements are watched on a radar screen, separation can be drastically reduced, and more rational use made of the airspace. The traces of four aircraft (A-B-C-D) can be clearly recognized on the screen here, thanks to the long afterglow.

transfer is made from controller to controller by interphone lines, since the radar controller at the centre must know the exact location of the aircraft for which he is accepting responsibility. He has obtained the departure time from *Super 123* immediately after take-off and has also calculated the estimated times over the coming reporting points, exactly as the departure controller who issued the clearance had done for the sector controller.

Let us assume, then, that *Super 123* has been passed to the radar controller immediately after take-off. The pilot reports on the appropriate frequency and now receives further instructions for his climb. Naturally, the controller will try to get him onto his cruising course as directly as possible. But we have already seen that there are five other aircraft on the airway, from which *Super 123* must be properly separated. This may mean that he will have to make some turns, so as to avoid other aircraft.



Only the use of radar in air traffic control can enable the steadily growing volume of air traffic to be handled with adequate safety and regularity. Picture shows an L-band long-range surveillance radar by Compagnie Générale de TSF, Paris.

Meanwhile, the flight plan data, together with the estimated time over the first reporting point in the adjacent area, have been passed on to the next centre, and before *Super 123* enters the new control area the pilot is instructed to contact the next centre—in this case Hanover.

Super 123 is now handed on from sector to sector and from one area control centre to the next. Each controller watches the aircraft's progress and makes sure that the international separation standards are maintained, so that no danger of collision with other aircraft can arise. This demands the utmost concentration from every individual. The controller's attention must never waver; and he may not make the smallest error, since even a misunderstood or hastily read—and hence perhaps *mis*read—figure can lead to a catastrophe.

At the last centre, in whose area *Super 123's* airport of destination lies, the controller will try to fit the aircraft at the best possible moment into the approach sequence, which is fixed for all aircraft flying to the same airport. The principle here is, first come, first land—even if the time difference is only one or two minutes. But to carry out this principle, the aircraft arriving over the approach fix must be arranged in altitude in such a way that the first to arrive is at the lowest altitude, as it obviously must not descend through the levels of the other aircraft flying in its vicinity.

Planning of the approach sequence begins very early, often before aircraft enter the last control area. If *Super 123*, for example, were the first aircraft in the approach sequence, the controller would try to get it down from its cruising altitude in good time, so that it reaches the beacon at the optimum altitude. Once again, radar renders invaluable services. If it were not possible to get *Super 123* down from FL 140 in time, then the aircraft might have to remain at this flight level until it reached the beacon . . . But there all the aircraft at lower altitudes —even if they arrive at the beacon a few minutes later—would be called in for the approach before *Super 123*.

If the controller has managed to get *Super 123* to the correct approach altitude in time, then the aircraft is handed over to approach control not later than on arriving over the beacon. Approach control then safely guides the aircraft to the airport and even undertakes, in the case of GCA approaches, to relay the landing clearance from the tower to the pilot. ←

Air traffic control

Automatic Commutated Antenna Visual D/F System

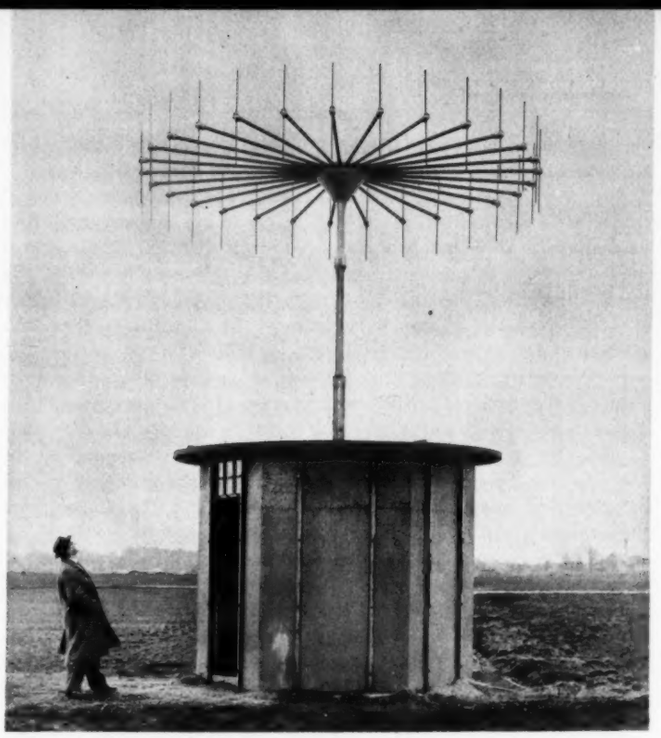


Fig. 1: Rohde & Schwarz wide base-line D/F antenna with 29 dipoles, shown here for the VHF band.

The well-known Munich electronics firm of Rohde & Schwarz has developed two new models of visual display D/F equipment with commutated antennas, both of which are based on the latest developments in direction finding techniques. These bear the designations NP 4 (VHF band from 100 to 156 Mc/s) and NP 5 (UHF band from 225 to 400 Mc/s) and are designed in the first place for use in air traffic control. The two systems work on a circular antenna array consisting of 29 dipoles *(fig. 1)*, which are mounted on arms supported by a central mast. Inside the antenna head is a *wide base-line goniometer* which scans the antenna circle with the aid of a rotating capacitive coupler. The goniometer simulates the rotation of a single antenna and at the same time superimposes a frequency modulation on the existing amplitude modulation of the received radio wave. The resulting frequency shift depends on the speed of rotation and the radius of the antenna circle. The wide aperture of the antenna system considerably reduces the effects of unwanted reflections from objects in the neighbourhood of the equipment, so that bearing errors and variations are substantially smaller than with the conventional Adcock antenna.

Each installation consists of the *D/F station proper* with its wide base-line antenna and related equipment (main installation) and the various *display points* (slaved displays) with visual panels showing the bearing readings. The latter are installed in the control tower, approach control and area control centres; there is also a master display in the main D/F station.

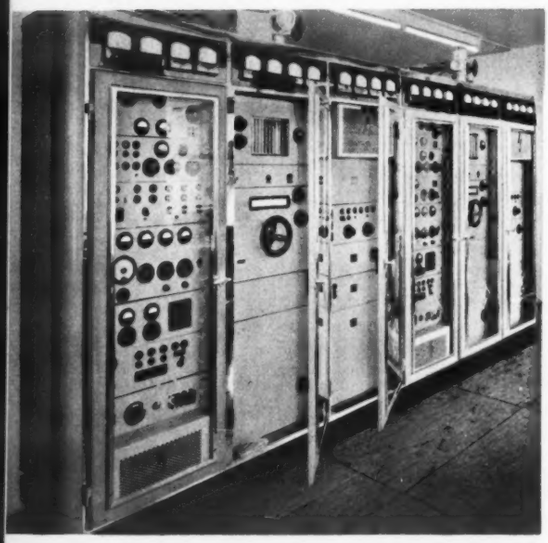
The *main station (fig. 2)* also houses a series of crystal-stabilized D/F receivers, their number depending on the number of frequency channels it is desired to use simultaneously for transmission of information to the visual displays. In addition each *visual display* is equipped with a frequency selector (row of push-buttons) used for switching to one of these receivers. All receivers are connected to the common D/F antenna via antenna discriminator amplifiers. Where several frequency channels are available, but only one or two are used simultaneously, one or two D/F receivers with remote channel selection will suffice. In this case the receiver is automatically tuned to the desired frequency by pushing the appropriate button. Each receiver can be tuned to 10 frequencies.

If desired, *combined UHF-VHF equipments* (NP 4/NP 5) can be supplied, when a UHF antenna is installed above the VHF antenna, and the visual displays can be used alternately for bearings in both frequency bands. These combined installations contain many equipments which are common to both frequency bands, so that they offer not only operational and space advantages but also economic benefits. Moreover, the NP4 VHF system can at any time be converted to cover the UHF band.

The number of visual displays at the *remote display points* is dictated by operational requirements. Each system has selector equipment for the desired D/F frequency channel *(fig. 3)*. On the display panel the bearing is indicated by a mechanical pointer which is actuated rapidly and smoothly by a servo-mechanism. The pointer lights up only when it is indicating an actual bearing reading and is practically invisible in the intervals. As it remains in the same position until the next bearing is received, the last bearing reading can always be consulted by means of a hand-operated repeater knob which causes the pointer to illuminate briefly. A special version of the visual display equipment also supplies two d.c. voltages corresponding to the X and Y components of the bearing value, so that the bearing can be introduced into the radar display in the control centre for identification purposes.

For transmission of the bearing values over long telephone cables, use can be made of the *NZ 160 digital remote transmission system*, which ensures error-free transmission even over cables with a high interference level. On the receiver side of this system the bearing value can either be indicated by a pointer on an azimuth scale or be introduced direct into the radar display. Finally the bearing value can be shown on a *fixer display*, where the position of the airborne transmitter is determined from the point of intersection on a transparent map of traces from several D/F stations at different locations.

The visual D/F systems described here have been tested by several European traffic control centres, in some cases at very unfavourable sites where the Adcock systems produced no useful results. They have been used for some time at all the commercial airports in the Federal German Republic, and will shortly also be introduced in Switzerland, Austria and Sweden. ⟶



◀ *Fig. 2:* Main station for the NP 4 D/F system.

Fig. 3: Slaved visual display for the NP 4 D/F system, with push-buttons for channel selection.

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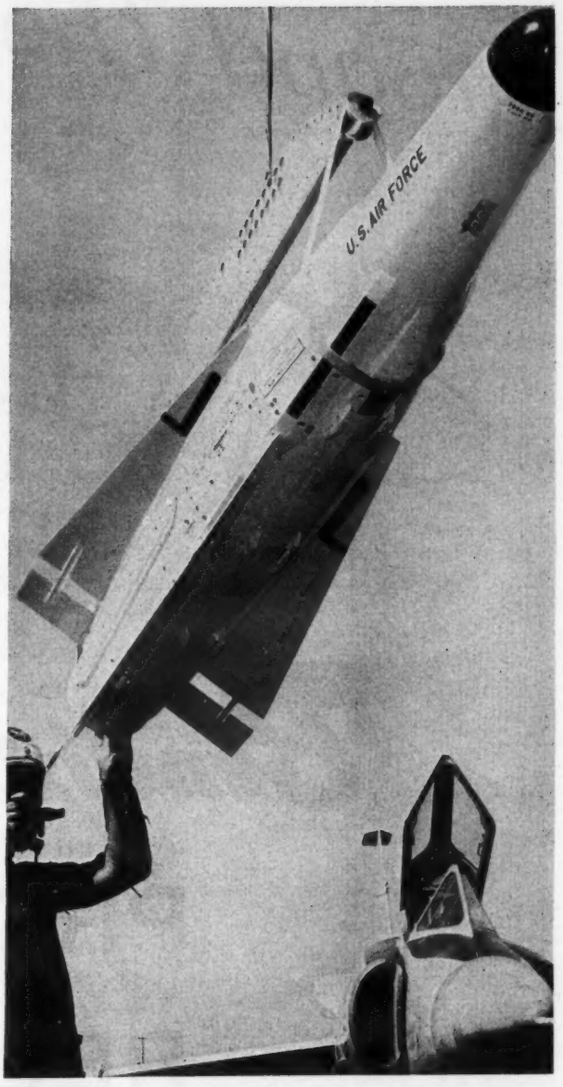
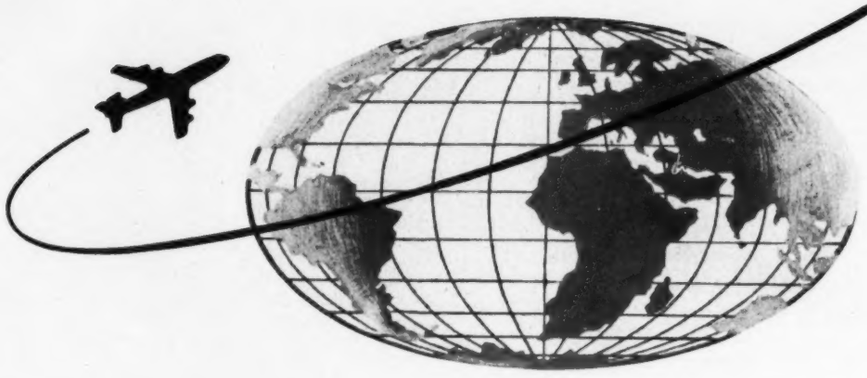


Larger than earlier Falcons, yet small considering its nuclear capability, the GAR-11 is 7 feet long, 11 inches in diameter and weighs slightly more than 200 pounds.

Around The World



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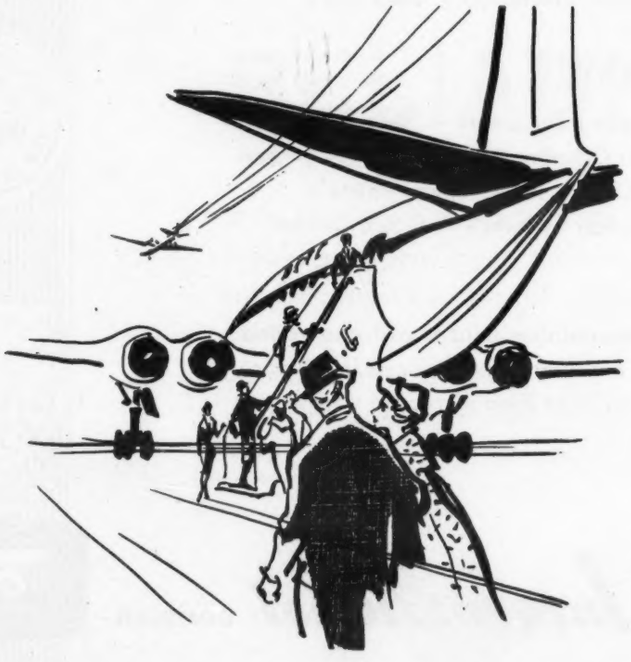
The system has been ordered by The Netherlands Government and the first phase is now on operational test.



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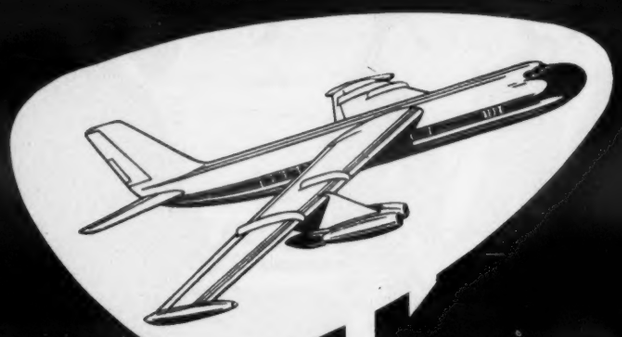

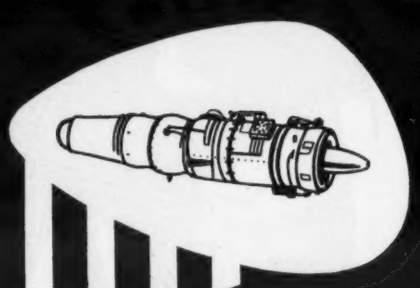

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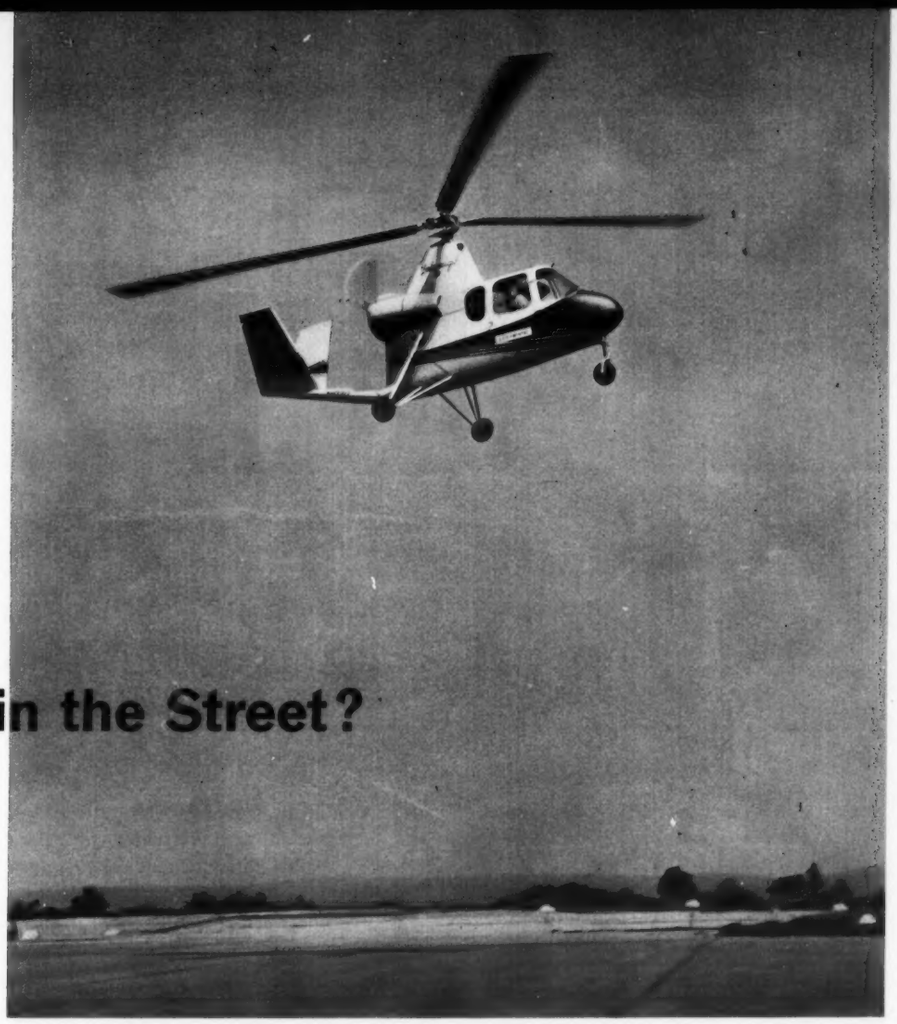
Umbaugh 18

A Rotorcraft for the Man in the Street?



Prototype of the Umbaugh 18 two-seat autogyro . . . still with butterfly tail.

It is always heartening to meet optimists. This pleasure fell to the lot of *Interavia's* New York correspondent, who went to Hagerstown, Maryland to inspect the first production version of the Umbaugh 18 autogyro (with 180 h.p. Lycoming engine) and received the following information from representatives of *Umbaugh Aircraft Corporation* and *Fairchild Engine and Airplane Corporation,* with which it is associated in the project.

1 – The Umbaugh 18 two-seat autogyro is being mass-produced on the same principles as the American automobile.

2 – By the end of December this year a total 640 Umbaugh 18s will have left the Hagerstown plant, but later plans envisage a maximum output of 72 per day.

3 – The aim is to produce at least 10,000 autogyros, to cover the costs of purchasing time-saving equipment and tooling.

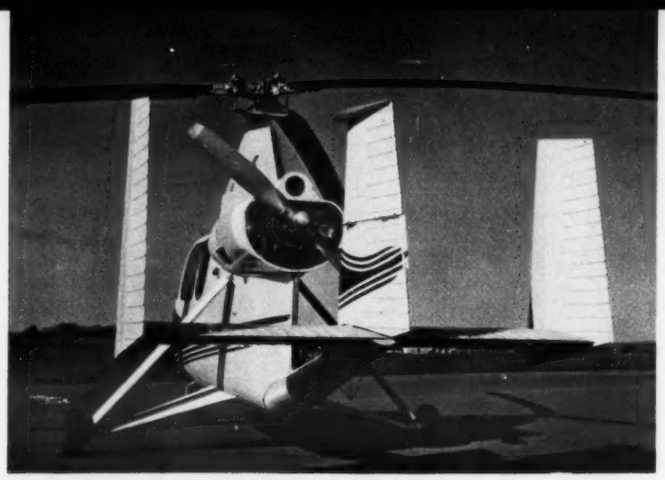
4 – The unit price is $9,995 fly away factory, and the operating and maintenance costs are estimated at about 6 cents per mile.

5 – By the end of September this year American sales agents had received part payments for over 10,000 autogyros, and a worldwide sales campaign is shortly to begin.

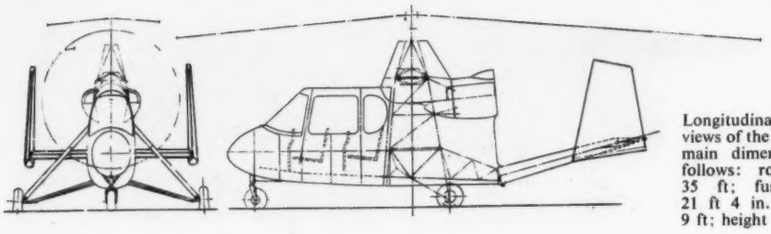
So far, so good. But the sceptics, who are also plentiful in this line of business, have calculated that a daily production of 72 means an annual output of about 20,000 aircraft, with 60,000 good sound rotor blades. Moreover, if the production plan for the first three months is maintained, hundreds of autogyros might have to wait for type certification. It remains to be seen how the manufacturers' first-quarter report will look . . . In the meantime let us take a glance at their philanthropic product.

The technician is impressed: The fuselage centre consists of a robust steel tube structure for the rotor head and engine and is covered with light alloy skin panels. The forward fuselage, on the other hand, is of monocoque construction and has large windows and two seats in tandem. The three-blade rotor, 35 ft in diameter, has fully articulated folding blades. Auto-rotating in the normal way, the rotor can be connected to the engine via a clutch before take-off, so that the pilot can

The production version has a triple-fin tail with a rudder on the central fin.



Rear view: rotor head with flapping and drag hinges; Lycoming horizontally opposed four-cylinder engine (180 h.p. take-off rating); Hartzell variable-pitch, constant-speed propeller; Goodyear light undercarriage.



Longitudinal and profile views of the autogyro. The main dimensions are as follows: rotor diameter 35 ft; fuselage length 21 ft 4 in.; track width 9 ft; height 10 ft.

accelerate it to a given speed; he then declutches the drive and abruptly increases the rotor blade pitch for a jump take-off. In flight, the gyroplane is stabilized about its pitch and yaw axes by a triple-fin tail unit, but longitudinal and lateral control are achieved by tilting the rotor's axis of rotation. Additional directional control is effected by a small rudder on the central fin. Also worthy of note are the light metal nose-wheel undercarriage with Goodyear mechanical brakes, and the Lycoming horizontally opposed four-cylinder engine—no doubt an O-360—with Hartzell twin-blade variable-pitch propeller.

The sports flyer and the air-minded businessman must have been equally impressed: They have been offered a low-cost aircraft which, unlike the helicopter, they can easily learn to handle and which has VTOL qualities. The jump take-off with prerotated rotor does not seem unduly difficult, and if the engine fails the pilot can glide under auto-rotation, requiring only a few yards in which to come to a stop. Moreover, the Umbaugh 18's maximum speed is 126 m.p.h.; cruising speed 100 m.p.h.; range 350 miles; service ceiling 15,000 ft. It seems almost too good to be true.

*

Raymond E. Umbaugh, President of the aircraft company which bears his name, gives the following reasons for his daring venture.

"My company, The Umbaugh Chemical Fertilizer Company, specialized in custom blending of fertilizers. We sent a hundred salesmen right into the farmers' backyards, and I chafed at the non-productive time lost in automobile travel. I put most of my hundred salesmen into the air, with helicopters, *Bonanzas,* even DC-3s and C-46s. We quintupled our business, and during the seasonal rush my ace salesmen actually did ten times as much business. The helicopters' total operating cost, including the pilot and maintenance, came to $1.21 a mile. To put all my salesmen in the air would have cost $4 million for 100 helicopters. We figured we could build 100 small gyrocopters for an output of $2 million and do away with the prohibitive operating cost.

"We realized that if the machine could be designed so that the user could learn to fly it easily, and if it could be manufactured at low enough initial cost to appeal to a mass market, we could fill our needs and present a further business opportunity from the standpoint of manufacturing planes. We . . . began our program 3½ years ago in Ocala, Florida."

Raymond E. Umbaugh and his collaborators have done a great deal of work in these 3½ years: they have engaged as Chief Engineer *Gilbert DeVore,* a helicopter expert of long standing, a former CAA flight test engineer and at one time Design Engineer and Chief of Flight Test for Fairchild's Personal Planes Division. They obtained support from a number of sub-contractors, including Parsons Inc., Traverse City, Michigan (rotor blades), the Lycoming Division of Avco, Stratford, Connecticut (engine) and Goodyear Tire and Rubber Co. (undercarriage), with an eye to price reductions for quantity orders. The metal structures and final assembly are the responsibility of the Fairchild Engine and Airplane Corporation of Hagerstown, Maryland.

The prototype is already flying. Let us be wary of awarding praise until, say, the hundredth autogyro is in the air. ⟡

Construction of the first two experimental models. At least 10,000 production models are to follow, according to Raymond E. Umbaugh's plans.

Vienna-Schwechat Airport

By K. Prochazka, Interavia, Geneva

Forbidden all activities in the field of aviation after World War II, Austria had to stand idly by watching air traffic develop by leaps and bounds all over the world. The division of Europe relegated Vienna, a vital junction point before the war, to a forgotten corner on the fringe of the Iron Curtain. Vienna-Aspern, which was served in the thirties by ten airlines and was a leading international airport, was destroyed during the hostilities in 1945 and occupied by the Red Army. A military airfield built during the war at Tulln, 20 miles north-west of Vienna, was taken over by the Americans; the airport of Schwechat-Heidfeld, 11 miles to the east of the city and a Heinkel test centre during the last years of the war, was placed under British control.

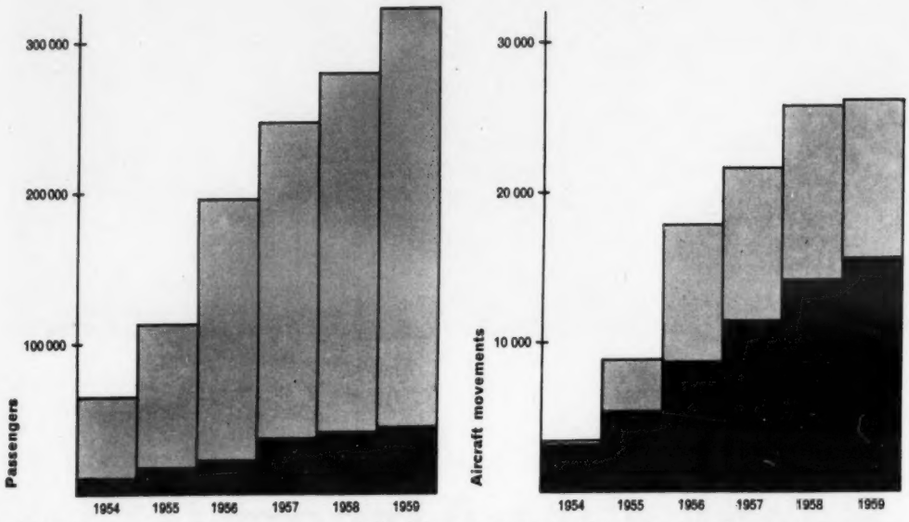
All these airfields were at first used for purely military purposes. But as the Allied airlines gradually came to include Vienna in their networks, they flew to the airfield which was "politically" nearest: Pan American landed at Tulln, BEA at Schwechat and Aeroflot at a Soviet-occupied airfield near Bad Vöslau, 22 miles south-west of Vienna, as Aspern could not be used for civil traffic. A few other companies, which gradually opened infrequent services to Vienna, also used Schwechat because it was the nearest to the city. Vienna thus possessed three "airports," with barely two dozen commercial landings a week ... an ironic comment on the country's partition.

In 1953 the British declared themselves willing to hand Schwechat over to the Austrian authorities. After lengthy negotiations, an airport operating company was set up on December 11th, 1953; the capital was held 50 percent by the Federal Government, 25 percent by the City of Vienna and 25 percent by the province of Lower Austria, on whose territory Schwechat lies. On January 1st, 1954, the airport operating company took over the airport with its installations, which were barely adequate to cope with traffic operations: a concrete runway 4,900 ft long and 197 ft wide, a concrete apron covering 64,600 sq. ft., taxiways covered with pierced steel plate and a few hastily patched up buildings ... The rest was ruin and desolation. Permanent plans had for the time being to be abandoned for a few facilities to meet the minimum requirements of scheduled air transport. An old hangar was converted to a temporary terminal building by the installation of wooden fittings; the traffic office, freight, customs and air traffic control services were given the bare minimum necessary to carry on operations, the runway was reinforced, lengthened to 6,560 ft (partly with prestressed concrete) and fitted with high-intensity lights, Calvert approach lighting and an ILS installation.

Planning begins

All those responsible were fully aware that this work could lead only to an interim solution, and in spring, 1954, a committee was set up to work out a plan for the extension of the airport. After a series of preliminary investigations with the collaboration of the well-known airport architect Heinrich Kosina, a competition was organized the following December for a general extension plan and the design of the terminal building. With such an attractive project, it is

Apron side of the terminal buildings. The clear distinction between pathway, service road and apron ensures freedom of movement. The passengers use the footpath bordered by shrubs and walk under the visitors' platform in bad weather, while the airport vehicles have a road thirty feet wide.



The development of traffic since the airport was handed over to Austrian administration. Left, the number of passenger movements per year (transit passengers in black); right, total aircraft movements (scheduled traffic in black). Each take-off and each landing counts as a movement.

small wonder that many solutions were received. The prizewinners—Dr. Fritz Pfeffer, Dr. Kurt Klaudy, Adolf Hoch and Anton Schimka—were invited to form a working group and in July, 1955, were entrusted with the overall planning for the airport.

Before the final plans were made, however, it had to be decided whether Schwechat itself fulfilled all the requirements as regards the site for a modern commercial airport. Vienna is in the happy position of having several suitable sites in its immediate vicinity. But after a careful weighing of all the pros and cons the choice again fell on Schwechat, for the following reasons:

- The weather conditions — prevailing north-westerly and south-easterly winds, an average of 350 hours' fog a year—ensure maximum utilization for an airport with single-direction runways.
- The site is to a great extent free of obstructions, and air traffic control is unhampered.
- Agriculturally, the land is inferior, so that the airport, while highly suitable for building projects, is not taking up fertile soil.
- Two parallel runways separated by a distance of 3,900 ft can be built; this would permit the simultaneous use of both under instrument flying conditions. The main runway can be extended to a length of 14,800 ft, the second to 8,200 ft.
- The installations already available could be incorporated in the project, thus saving money.
- The city centre is only 11 miles away.
- The existing access road, which is relatively free of crossings, can be widened to take four tracks, and a line has been laid down for a fast motor road without crossings, leading to the city centre.

The first class restaurant; in the rear is a tapestry designed by Professor Eisenmenger.

- The Vienna-Salonika motor road planned under the European motor road network programme will lead past the airport, connecting it to a highly efficient road transport system.
- A railway line bordering the airport could easily be transformed into a fast rail connection.
- Finally, the airport's immediate surroundings are only thinly populated—the nearest communities lie two to three miles away—so that the much-discussed noise disturbance to the population could hardly impede operations.

Against these advantages, there are only two disadvantages: instrument flights from the west lead over the city, although at great heights; and aircraft approaching from the east come near the frontier, in this case the Iron Curtain where frontier violations can sometimes have unpleasant consequences.

In the meantime, the peace treaty had been concluded. Freed from the bonds of occupation, reconstructed Vienna rapidly returned to what it was before the war: a centre of theatrical and musical life, an international meeting-place and a showplace for tourists. The patched-up ruins at the airport presented a lurid contrast with the buildings of the Ringstrasse, which had arisen in all their former glory. Although the formation of political and economic blocs in Europe had robbed Vienna of her significance as a railway goods junction, a gratifying development was beginning to make itself felt in the air traffic to Vienna, which was becoming a south-eastern air junction. Schwechat was among the first airports where the air traffic networks of East and West met.

It was for these reasons that the architects decided to base their extension plan on an optimistic traffic forecast covering a period of 15 to 20 years, as is usual with airport projects. With an estimated average annual increase of 12 percent, the traffic volume for 1975 will rise to over two million passengers. It was, of course, impossible for economic reasons to expand the airport to its full capacity at a time when the traffic volume was only one sixth of that ultimately expected. The main aim in the first phase of the building programme was to provide a facility which would ensure the smooth passage of traffic for the next five to ten years and which could be enlarged at any time as occasion demanded. This latter requirement presented the architects with a difficult task, particularly in the design of the terminal building. Although the intermediate phases of the programme are designed as integral parts of the final project, they must not give an impression of incompleteness but must make their effect as a harmonious whole. The late "return" of Austria to air transport had its good side in that airport planning, unhampered by existing installations and taking advantage of experience gained in other countries, could take full account of the requirements of jet traffic right from the start. The few existing facilities were integrated into the design almost automatically.

The most pressing tasks were included in the first phase of the programme, which comprised the following work: extension of the runway to 9,800 ft, construction of taxiways, laying of a new apron and, above all, the erection of a terminal building and control tower. After three years of building, these facilities were opened on June 17th, 1960.

Functional and elegant ... the terminal building

While the passenger gives only a passing glance at runways and taxiways, air traffic control installations and the other technical equipment of an airport, he devotes far greater attention to the terminal building, for it gives him his first impression of a new country and is in a certain sense its visiting card. Vienna-Schwechat has succeeded in combining practical functionalism with a tasteful style and a note of Viennese elegance.

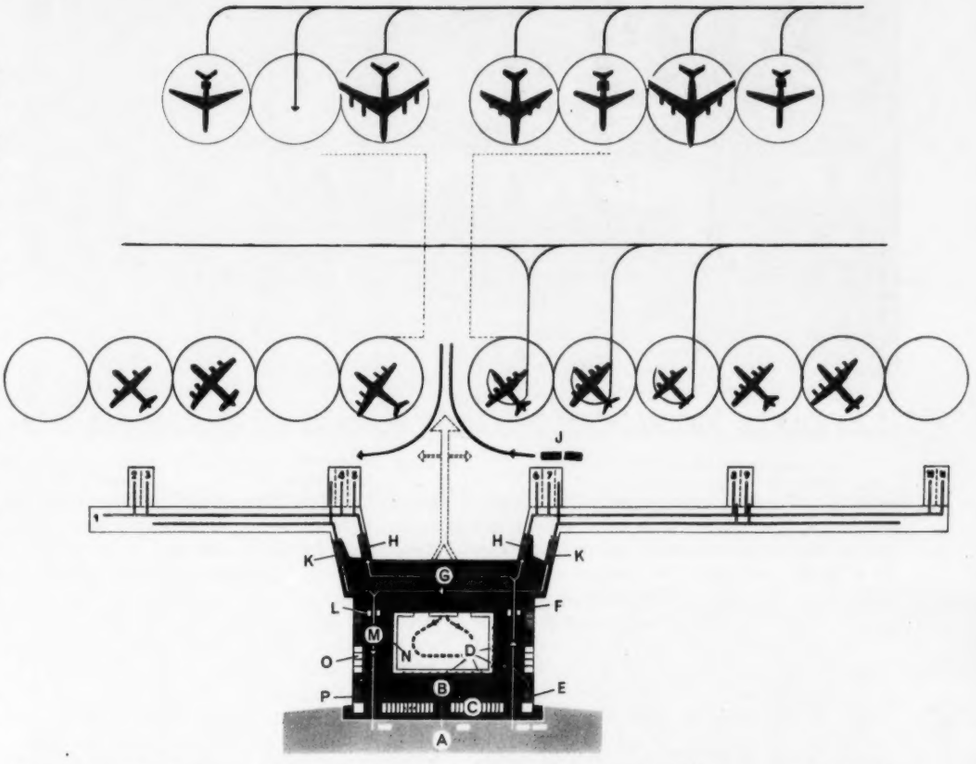
Forming a gentle curve on the airport side, the terminal building falls into four sections which differ markedly from each other, not only in their functions, but also as regards their external design. The focal point of the building is the 260 ft long and 60 ft wide terminal lounge, which at once catches the eye with its sloping glass surfaces and curved roof. It extends westwards in a three-storey restaurant wing, and on the eastern side it connects up with a four-storey office block. The façade is accented by the 115 ft control tower at the eastern end of the building.

The central hall has two floors; passenger handling takes place on the upper floor, while the ground floor is reserved for baggage, mail and health services. The basement, which is connected with the apron via ramps, serves for the maintenance and loading of apron vehicles. To separate the stream of arriving passengers from that of departing passengers in the terminal lounge, there is a central island, with two ramps for baggage trucks leading to the ground floor. To the west of the island lies the departure area, to the east the arrival area. The ring is closed by the transit lounge to the south and the vestibule to the north. A lowered roof section, suspended on steel cables over the island, makes it appear less conspicuous than the passenger areas, at the same time providing high windows giving plentiful light to all the halls, even those facing away from the sun.

The accompanying diagram shows the path followed by the passengers. Here let it suffice to mention the principle of hiring departure desks on an hourly basis, which has been consistently applied at Schwechat. The desks at which the baggage is weighed in and registered are hired out to the airlines in rotation, as and when required. If an airline expects a large number of passengers for its next departure, it rents several desks at once, thus saving its passengers a long wait. The customs officials make spot checks on the baggage as it is registered. It is then taken by truck from the scales to the aircraft; on their return journey, the trucks bring the baggage of arriving passengers to the customs benches bordering the island on the side of the arrival lounge. The use of conveyor belts, chutes and roller tracks was deliberately abandoned, as they increase the risk of baggage being damaged or mislaid.

The plans for the final phase envisage the vertical separation of arriving and departing passengers. The ground floor will then serve as an arrival lounge; the postal and health services which at present occupy this floor will have to be moved into a new building. The designers of the hall have painstakingly avoided any kind of internal supporting wall, so that there is nothing to prevent radical changes in handling procedure which might be brought about by, say, the abolition of passport and customs examinations.

The ground floor of the west wing contains the kitchen, rooms for the preparation of airline



Passenger routeing diagram. All departing passengers arriving at the airport by taxi, public transport or private car, arrive directly in front of the terminal building by a ramp (A). In the vestibule (B) they find the airline booking and information offices (C), and the post office, bank and a few shops. The baggage is weighed in at the baggage reception desks (D), registered and if necessary customs cleared; it is then taken to the aircraft by electric trucks. The passengers already cleared in the city terminal leave the airport buses on the ground floor and reach the hall by escalator (E). The baggage already registered is loaded directly from the bus onto the trucks. If the customs should wish to check any pieces of baggage, these must pass through the baggage reception desks on the upper floor. Four passport control channels (F) lead to the transit lounge (G). After departure is announced the passengers follow signs down escalators (H) to gates (1 to 11); each of the latter corresponds to an aircraft position in front of the building. Passengers are taken to external jet aircraft positions (I) by bus from gates 6 and 7.
Arriving passengers enter the building by the gate nearest their aircraft, reaching the transit lounge by escalators (K). Apart from the lounge and buffet, transit passengers have a large restaurant with a view over the airport apron, rest rooms, baths, hairdresser and conference rooms. Other passengers are taken through the passport control (L) in the arrival lounge (M). While awaiting their baggage, which is put on the customs benches (N), they can change money, hire a car or book a hotel room at desks (O). The airline buses wait on the ground floor, where they can be reached by escalator; taxis, private cars and public transport depart from the ramp (A).

This is the way the terminal building looks to the passenger arriving from the town. According to the architect, the line of the concrete roof, which is just over 2¼ in. thick, symbolizes the take-off and landing curve of an aircraft.

The departure lounge. There is no fixed allocation of departure desks; individual airlines hire them in the required numbers before flights. This not only ensures the proper utilization of available space, but also avoids long queues.

meals, a self-service canteen and VIP lounges. On the first floor is the transit restaurant for 150 people; and far to the west is the waiting room for domestic passengers. The visitors' restaurant for 450 people takes up the greater part of the second floor. The tables are arranged in two galleries, so that all the patrons can enjoy an unhindered view of the apron. There remains the first class restaurant, where a tapestry by the Vienna factory adds a particularly distinctive touch. Sliding partitions enable the respective sizes of the restaurants to be altered according to the numbers to be served.

Special stress has been laid on the artistic decoration of the parts of the airport which are accessible to the public: compositions of photographs and drawings, mural paintings, marble inlays, a tapestry, engraved glass, mosaics and an abstract statue give a typical impression of contemporary Austrian art.

Far from the bustle of the terminal building, the east wing serves as an office block. On the ground floor there is a spacious pilots' lounge, which leads to the flight information and meteorological offices. A considerable part of the building is occupied by the air traffic control technical service, which is being radically modernized during its transfer to the new building. The airline offices are also housed in the east wing.

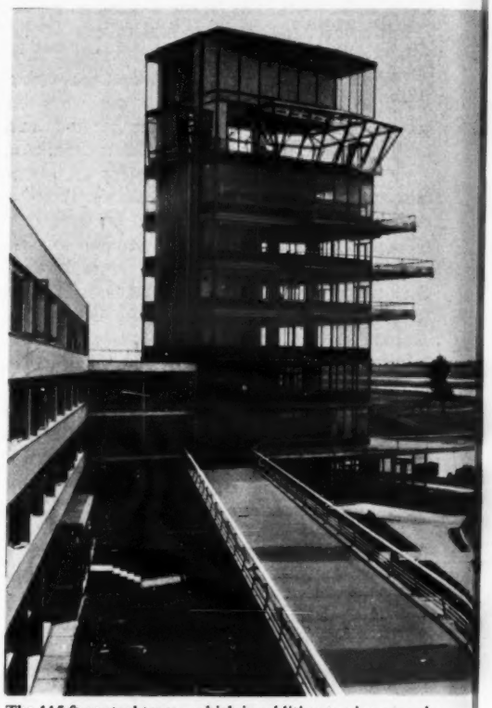
The control tower, which is at present at the end of the group of buildings, will be in the centre when the project is complete, giving the controllers a clear view of the entire airport terrain. The staircase on the north side and a few slender columns provide the sole support for the cantilever platforms in the form of double floors to take the cables and ducts of the air conditioning plant; the controllers' field of vision is virtually unobstructed. The tower is being prepared to house the airport and approach control services, and will also accommodate the area control service. An added facility will be the installation of a flight simulator and radar simulator for pilot training in instrument flying procedures.

Over 10,000 visitors a day

The airport has proved so attractive to visitors that on several occasions it has been overrun and the doors have had to be temporarily closed. This is, however, by no means the fault of the architects, for sightseers have certainly no cause to complain of niggardly treatment. A wide visitors' gallery with projecting platforms forming shelters over the apron gates runs along the entire front of the building. By adding a second ceiling over a part of the transit lounge, an inner gallery was created, from which a spiral staircase leads down to the outer gallery. Visitors accompanying passengers can remain in continuous contact with them until they board their aircraft. In addition, the entire roof of the restaurant wing, which can be reached by a staircase tower, is open to visitors. Finally, there is a large terrace with a buffet, which forms a continuation of the restaurant block towards the west. Revolving doors with slot machines at the entrance to the gallery ensure a welcome additional income for the airport.

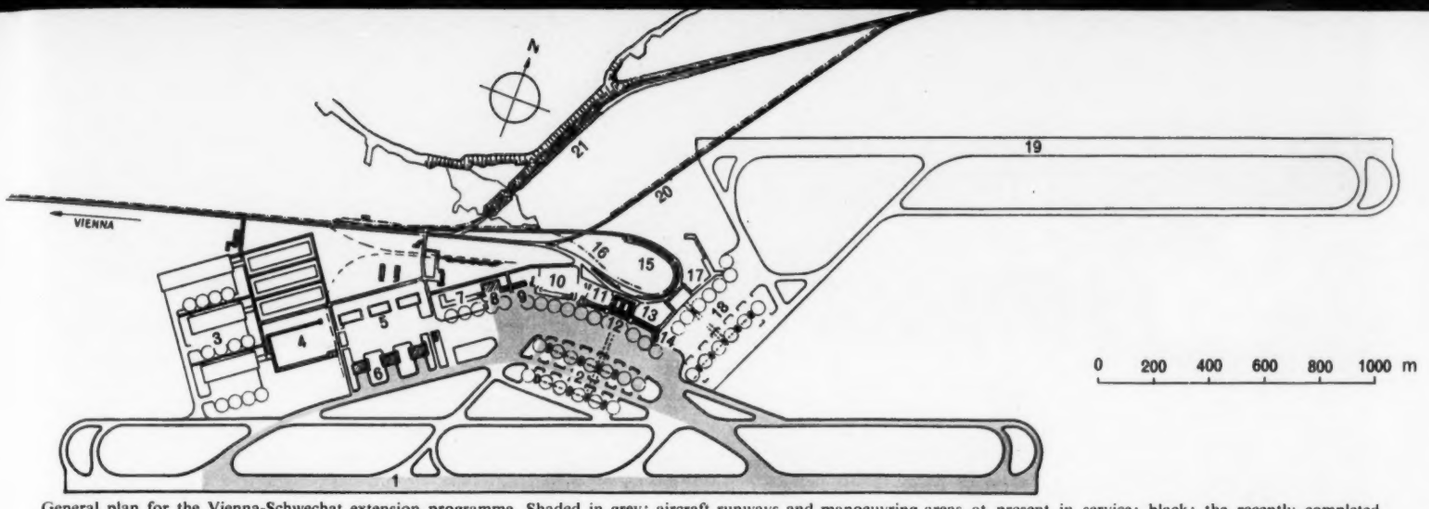
Advanced building methods

When we learn that the chief architect is also a civil engineer, or more properly speaking a stress analyst, it is understandable that new solutions to constructional problems are encountered at every step. The curved roof of the terminal building consists of a prestressed concrete skin just over 2¼ inches thick, for which a special covering had to be developed owing to the sharp differences in inclination. The restaurant and office wings are also prestressed longitudinally, enabling the lengths of concrete between the expansion joints to be increased from 115 to 330 ft. The reinforced concrete framework was made of white smooth-finish concrete, using processes employed in the production of artificial stone and joiner-made forms instead of the normal shuttering. The design of the huge glass surfaces in the transit lounge gave the planners severe headaches, for the windows had to make the inside of the building soundproof against the noises on the apron, withstand bending stresses due to the force of their own weight (the surfaces are inclined) and resist vibrations due to engine noises. Finally, a satisfactory solution was found: the glass plates—two per section with a cushion of dry air between them—are bedded in flexible plastic mounts, which are held in position by steel frames, flexibly mounted in their turn. The doors in the passenger section of the building, which are automatically operated



The 115 ft control tower, which in addition to airport and approach control will assume area control for the whole of Austria. The antenna of the surveillance radar will be installed on the roof. All rooms are fully air-conditioned.

The spacious arrival lounge where passengers await their luggage. If traffic increases, the customs benches can rapidly be rearranged and extended. The friezes show Viennese motifs.



General plan for the Vienna-Schwechat extension programme. Shaded in grey: aircraft runways and manoeuvring areas at present in service; black: the recently completed terminal building group; cross-hatched: old buildings.

1 – southern runway
2 – jet aircraft stands
3 – overhaul depot and repair workshops (planned)
4 – service depot (workshops, auxiliary equipment, store-rooms etc.)
5 – freight depots (planned)
6 – old hangars
7 – freight handling (planned)
8 – maintenance hangar (former terminal building)
9 – refuelling service building
10 – visitors' platform
11 – restaurant wing
12 – terminal building
13 – office wing
14 – control tower
15 – car park
16 – fast railway connection (planned)
17 – terminal building extension (planned)
18 – apron extension (planned)
19 – northern runway (planned)
20 – present position of Federal road
21 – position of Vienna-Bratislava Federal road after completion of programme, with fly-over leading to airport entrance (planned)

from pressure pads in the floor, are extremely practical.

The manoeuvring areas

The apron, which is built partly of prestressed concrete, has room for eighteen aircraft. There are eleven positions for propeller-driven aircraft, running the length of the terminal building; the remaining seven positions are about 600 ft away from the building and are reserved for jet aircraft. The jet aircraft do not have to turn and can therefore taxi under their own power without endangering operations on the apron. Passengers arrive at the propeller-driven aircraft on foot, the maximum distance to be covered in the open air being little more than 100 yards. At the moment, passengers are transported to the jet aircraft in buses, which are, however, later to be replaced by highly manoeuvrable special vehicles with low floors and several doors. The jet aircraft loading positions can be expanded to form a satellite unit which would be connected with the terminal building via a tunnel. Remote-controlled lights on 82 ft tubular masts ensure even lighting for the whole apron without dazzling ground personnel and pilots.

For the extension of the runway 3,300 ft to the east, use was made of a new method of crosswise prestressing concrete slabs which has aroused considerable interest in the building world. The 74 ft wide taxiway is also of prestressed concrete, bordered by two 23 ft asphalt shoulders to ensure that the engines of even the largest jet aircraft are always above a paved surface, thus practically eliminating the danger of foreign bodies being ingested.

On the city side, too, traffic areas have been created to meet all present-day requirements. A ramp 30 ft wide passes in front of the terminal building to the first floor. Spacious parking places can accommodate 800 private cars, while a further 120 can be parked in an underground garage. The parking facilities can be expanded to take 3,000 cars.

Building goes on

True to the saying "An airport builder's work is never done," building activity has been deliberately designed like a child's suit, large enough to allow for growth, so that it can meet all requirements for some time to come, but a series of further projects is already becoming urgent: the construction of a fast turn-off way, the installation of further aircraft loading positions for freight and the erection of a freight terminal. The runway is also to be extended 1,640 ft to the west, and this will involve the resiting of the approach aids. An airport hotel is on the programme, together with a service depot with repair workshops and engine test stands. And in about ten years the growing traffic will no longer be able to make do with a single runway. Before the second runway can be built, the Federal road from Vienna to Bratislava must be rerouted; at the same time the airport access road will be built with a fly-over. Under the final phase of the programme, one runway will serve for take-off, the other for landing, an ideal solution which reduces the taxiways and aircraft taxiing times to a minimum.

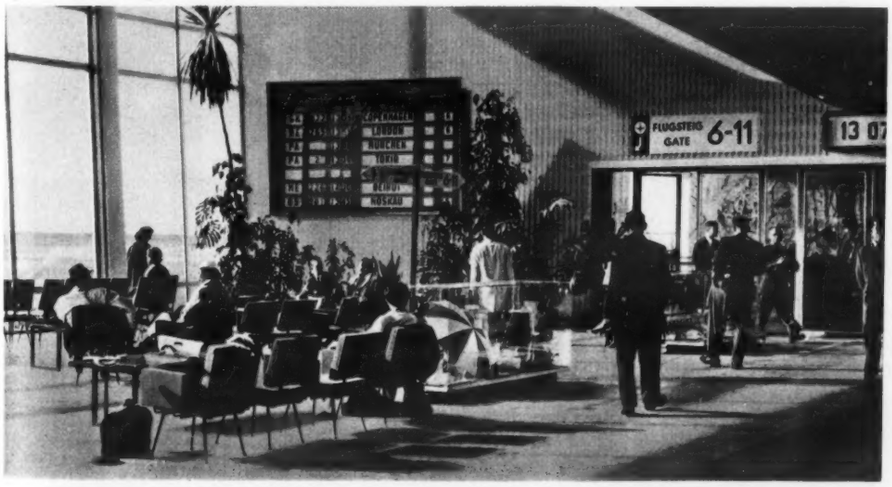
But the planners are looking still farther ahead and are already hunting for the most favourable site for a second airport, for even the spacious dimensions of Vienna-Schwechat will one day be inadequate for the ever-increasing traffic.

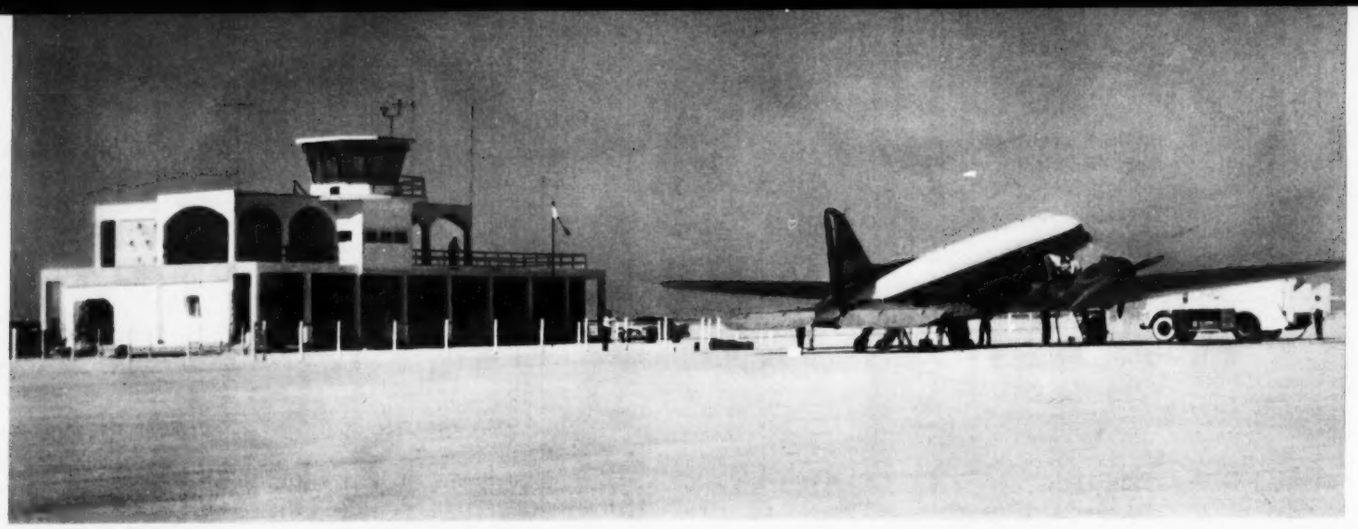
*

Austria cannot afford a large-scale aviation industry. But the installations at Schwechat which have so far been completed, installations which need not fear comparison with those of larger countries, show that Austria can nevertheless make a useful contribution to the development of civil air transport. ←

Some of the people responsible for the airport programme. Left to right: Franz Sasse, Airport Commercial Manager; Erich Föhner (seated), Vice-Chairman of the board of the airport operating company; Dr. Fritz Pfeffer (standing), Chief Architect of the Planning Office; former Under-Secretary of State Franz Winterer, Chairman of the board; Walter Huber, Director of Works; former Flight Captain Rudolf Hiller, Technical Manager of the airport, who flew two million kilometres with OELAG, the prewar Austrian airline.

The light, airy transit lounge gives passengers an unobstructed view of the apron. The next seven flights are posted on the remotely controlled mechanical indicator in the background.





The desert airport of Dubai at the southern end of the Persian Gulf, with an Iranian Airways Douglas DC-3. For the time being, a runway of compacted sand will suffice, and the arriving passenger is spared all customs and passport checks.

Dubai— New Desert Airport

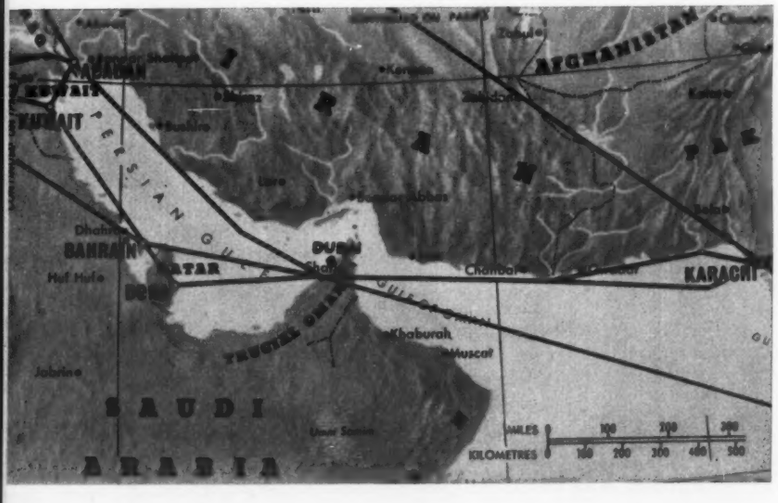
By G. R. Stroud, AFRAeS; MIN, International Aeradio, London

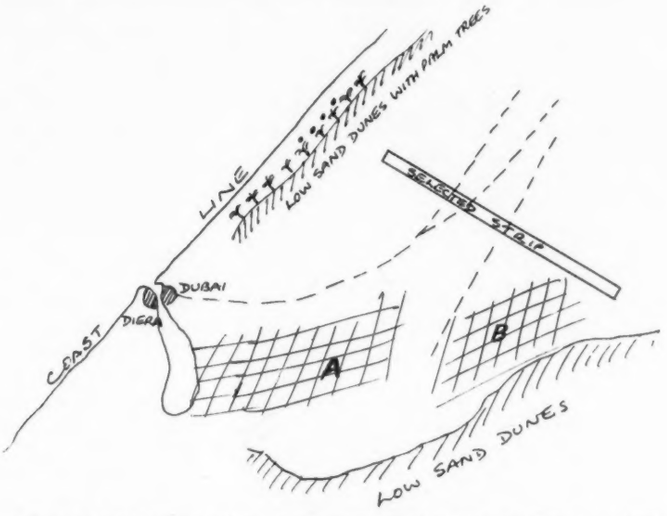
At the end of May last year Sheik Rashid Bin Said al Maktoum, Ruler of the Sheikdom of Dubai, invited International Aeradio Ltd. of London to build, equip and manage a civil international airport for him.

IAL called in Richard Costain Ltd., the civil engineering contractors, and a joint survey team went out in mid-June. The area was no novelty to the IAL men, for the company has been operating the technical services at Sharjah Airport in the Sheikdom next door for a decade and more. Dubai and Sharjah are two of the seven Sheikdoms of the Trucial Oman, which has a long-standing friendship with Great Britain. A general treaty of peace made back in 1820 was converted into a treaty of "peace in perpetuity" in 1853.

No oil-rich Sheikdom, Dubai has the best sea harbour on the coast, and is consequently an important commercial centre in the area, and growing fast under the wise direction of its ruler. Something therefore on a modest scale, able to meet the needs of today and tomorrow, but capable of ready and economical expansion, appeared to the IAL planners to fit the bill. Accordingly a recommendation for a single runway, taxi-track, aircraft apron and small terminal building, capable of handling aircraft up to and including *Dakotas* was made to the ruler, and accepted. Side by side with this would be aerodrome control, airport fire service, a non-directional beacon and, for the comfort of all, light, power, water and sanitation.

With five other tiny Sheikdoms, Dubai and Sharjah belong to the Trucial Oman, which concluded a peace treaty with Great Britain in the last century. Lines show the most important flight connections to centres of the Middle East, India and Pakistan.





Layout of Dubai Airport with its single runway, its palms and sand dunes. A = land threatened by the sea; B = land threatened by the rain. Broken lines indicate cart tracks.

The survey team came back with a load of soil samples to be analyzed and reported upon by Foundations Ltd. of London, and left behind a completely pegged out airport. The soil, consisting of silty calcareous sand, varying in colour from yellow-grey to grey-white, showed itself amenable to water compaction. A natural surface for the manoeuvring areas was therefore decided upon; a made-up pavement can follow later if required.

What of the problems? Paradoxically water, the possibility of too much of it, posed one of the main problems. Arabia, or by its more picturesque name Jazirat al Arab (Island of the Arabs), is an eastward sloping plateau, composed of granites and schists overlaid by sedimentary deposits.

Around Dubai the area is dead flat and seemingly endless desert; steppe-desert to be a little more precise, for it is broken here and there by low sand dunes and permanent coarse vegetation. "Help yourself" would at first sight seem to answer the question where to pitch your tent. This low-lying area, 1.42 feet above high-water mark however, is subject to sea flooding. From December to February the swell moving southeast down the Arabian Gulf ahead of a cold front, can be driven far inland by strong squally shamals (a local wind). The annual rainfall is low, less than four inches (nearby Sharjah 3.89), but is apt to fall "all at once" any time between November and January, leaving flooded areas which can stay put for up to two weeks. Sharjah has recorded a fall of 2.69 in. in twenty-four hours in November and 2.24 inches in January. The water table posed the third water problem;

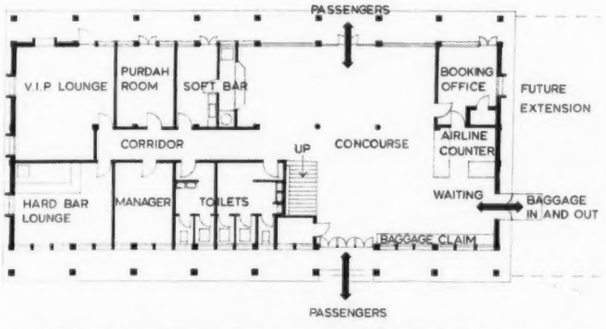
For the navigationally minded

IAL desk in the air-conditioned control room of Dubai tower.

Dubai Airport

Position	25° 15′ N 55° 20′ E
Elevation	5 feet (1.52 m)
Airport reference temp.	41 °C
Tower frequency	118.3 Mc/s
NDB frequency	265 kc/s. Coding DO, bearing 279° M 5,100 feet (1,553 m) from threshold R/W 30.
Runway	12/30°M 6,000 ft. (1,829 m), compacted sand, takes up to *Dakota* aircraft. Red and white threshold markings, red and white cone markers each side of runway.
Fire fighting facilities	1 foam/CO2 tender 1 water/CO2 tender
Refuelling facilities	All grades

No night landing facilities at present.



Plan of Dubai terminal building with booking office, soft and hard bars and a purdah room for the exclusive use of veiled members of the weaker sex.

as it is no more than three to four feet below surface, the proposed site for the airport buildings proved untenable. A shift to the west was necessary and called for a ground slab foundation built up above the natural level of the site; and an extra turning circle was called for to avoid excessive back-tracking on runway 12.

The usual problem of choice of runway direction existed, which becomes especially important in the case of a one-runway airport. The familiar land-sea breeze system was evident, giving generally north-westerly winds by day, with much lighter south-easterly winds by night. No meteorological records exist, of course, for the particular area. Guidance was obtained from the Air Ministry meteorological records at Sharjah, and much valuable help was given by the local Arabs who can be counted upon to know their winds and water levels.

No plant was available for constructing the manoeuvring areas, so it had to be brought down from Kuwait and put ashore on lighters, which was no easy task. The work started at the beginning of November and was completed in mid-January this year. Runway length is set at 6,000 ft to meet the airport reference temperature of 41 °C established from the Sharjah records. No account had to be taken of elevation or slope, as the survey showed a difference of only six inches in level in a strip of 12,000 feet long. In the general layout there is room for a parallel taxi-track, expansion of the apron, and the lengthening of the runway to 10,000 ft plus, when conditions warrant it. Obstruction clearances as for an instrument runway can be met now and in the future.

Work on the buildings started at the New Year, and September 30th saw the airport opened by the ruler, with the fly-in of a *Heron* of Gulf Aviation, carrying Sheik Maktoum, the ruler's elder son.

With a contented smile Sheik Rashid Bin Said al Maktoum, the ruler of Dubai, opens his city's international airport.

To inaugurate Dubai Airport, Crown Prince Sheik Maktoum flew into his father's domain on board a Gulf Aviation DH. *Heron*.

For an international airport Dubai certainly has one feature which will appeal to the traveller: there are no governmental controls. This also eased the task of planning the passenger and baggage flow and the segregation of internal, external and transit passengers. Little freight traffic is at present foreseen. Design philosophy behind the terminal building is ease of expansion as required in the future, without costly structural alterations. The addition of a controlled area, for example, would not be difficult. The building offers booking, refreshment and toilet facilities, and features a purdah room, and a waving platform extending along the roof on the airside.

To meet the natural local desire to do business, the resources of the Sheikdom were drawn upon to the limit. This resulted in practically all materials, fittings and the building labour force being obtained in Dubai itself. A notable exception was, of necessity, the air traffic control tower, atop the terminal building. Pre-fabricated by the Crittall Manufacturing Company to a basic International Aeradio design specification, it features dwarf walls, outward sloping windows double glazed with anti-sun glass, and double roof. The Controller can survey the surrounding scene from his sound-proofed, air-conditioned eminence, without leaving his IAL air traffic control console.

Rockets, Missiles and Space Vehicles

Dyna-Soar development

Under present planning a total of some $480 million is earmarked for development of the Boeing *Dyna-Soar* space glider up to fiscal 1963. Three vehicles are to be built for static tests, four for unmanned flight tests, and another four for manned flight tests. The programme also includes procurement of modified Martin *Titan* intercontinental ballistic missiles to accelerate the space glider to satellite speed, namely 15,000 m.p.h.

The latest timetable calls for a full-size mockup of a *Dyna-Soar* to be completed early in 1961; a first flight test with an unmanned vehicle should then follow some eighteen months later, with a Boeing B-52 probably being used as carrier aircraft. A first test with an unmanned *Dyna-Soar* with a *Titan* as booster is scheduled for early 1964, and the first flight with a human crew for early 1965.

First official picture of the Boeing *Dyna-Soar* space glider. The research craft is later to be developed into a global-range bomber or reconnaissance vehicle for the U.S. Air Force.

Launching a *Dyna-Soar* with the aid of a modified Martin *Titan*. The chief external features which distinguish the booster from the ICBM *Titan* are the relatively large stabilization surfaces at the rear. The Martin Company has appointed A. J. Kullas as technical manager for development of the *Titan* as booster for the *Dyna-Soar*.

Boeing Airplane Company called the first of a series of bidders' conferences at the end of September to discuss the selection of subcontractors. Companies represented at this conference, which discussed flight control electronics, included the Autonetics Division of North American Aviation, Eclipse-Pioneer Division of Bendix, Hughes Aircraft, Lear's Astronics Division, Minneapolis-Honeywell, Sperry-Phoenix and Westinghouse Air Arm Division. The actual subcontractors selected will not be announced for some months. Major subcontractor items still to be discussed are the glider nose cap, accessory power unit, reaction control system for stabilizing and orienting the glider in space, the pilot's compartment pressure and temperature control systems and the secondary attitude reference system.

Samos launching fails

The first attempt to place a *Samos* (Surveillance and Missile Observation System) satellite into a polar orbit, carried out from Point Arguello Naval base, about 170 miles north of Los Angeles, on October 11th, 1960, was a failure. Apparently difficulties arose in the operation of *Atlas-Agena B* second stage, and the satellite did not reach its orbit. Main contractor for the *Samos* satellites, which are scheduled to become operational by the end of 1962, is Lockheed Aircraft Corporation's Missiles and Space Division.

Discoverer XVI attempt unsuccessful

The U.S. Air Force launched its *Discoverer XVI* satellite from Vandenberg AFB, California, on October 26th, 1960, for the first time using a *Thor-Agena B* as booster. The *Agena B* is 25 ft long, has a diameter of 5 ft and can be equipped with a special capsule for animals or cameras and infra-red homing gear. It weighs 15,000 lb complete with propellants, and 2,100 lb after burnout. The motor is re-ignitable. On this test the *Agena B* carried the normal recoverable instrument capsule (weight 300 lb) plus special equipment to prevent the tumbling which has hitherto been primarily responsible for the capsule's failing to re-enter the atmosphere correctly. The Air Force reports that *Discoverer XVI* did not go into the planned orbit, as the second stage failed to separate from the first; both fell into the Pacific.

Skybolt for USAF and RAF

When the U.S. Air Force began studies for an air-launched ballistic missile in 1957, it sought a weapon which could be used for the B-58 *Hustler* as well as the B-52, and later the entire series of British V-bombers. The B-58, the *Victor* and the *Valiant* were later dropped from consideration, and design requirements for the weapon were thus substantially eased. The Air Force has now mapped a $400 million programme to complete development of *Skybolt* by mid-1964. The development programme does not include any funds for production.

Meanwhile, the United Kingdom and the United States have drawn up a technical agreement on cooperative development of the ALBM, covering such matters as the participation of British technicians in the programme in the United States. The agreement states Britain's intention to purchase the weapon from the United States, but does not commit her to do so. British press representatives visited Douglas Aircraft in mid-September for briefing on the project, but the planned demonstration of a mockup and release of external pictures of the weapon were vetoed by the Pentagon.

The USAF and Douglas are confident that the *Skybolt* will meet its operational deadline of 1964 in Strategic Air Command, and can be available for Royal Air Force *Vulcans* a year later if Britain can provide the required support equipment by that time. The solid-propellant missile is designed to augment the primary bomb weapons of the B-52, particularly as a penetration aid to heavily defended target areas. The B-52 will carry four *Skybolts* (instead of two *Hound Dogs*) slung beneath the wings (the missile is reportedly about the same size as the Army's two-stage *Pershing*). The Air Force does not regard *Skybolt* or its shorter-range air-breathing predecessor *Hound Dog* as primary weapons at this time, although they may ultimately assume this role.

The development programme is regarded as a straightforward task, requiring no spectacular breakthroughs or inventions. Launching a ballistic missile from a platform moving at 600 m.p.h. does present stringent new conditions for guidance, though a system to handle this problem appears to fall readily within the existing state of the art.

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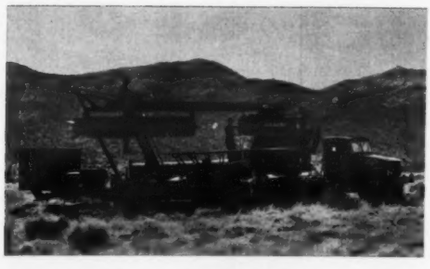
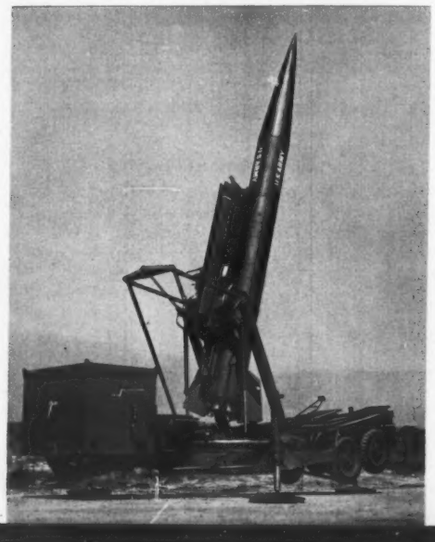
The National Aeronautics and Space Administration's four-stage *Scout* satellite booster (cf. *Interavia* No. 8, 1960, p. 978) on the launching pad at Wallops Island, Virginia. The solid-propellant rocket is to be used, for example, to orbit the first Anglo-American satellite (NASA Project S-51, American designation *International I*, British name *U.K. Scout I*).

Sergeant weapon system: The launcher is emplaced, the gas turbine power generator started, and the outriggers set in position. Then (below) the rocket motor is loaded and attached to the launching hooks. Next . . .



. . . the guidance section is attached to the motor section, and finally (below) the forebody section containing the atomic warhead is added.

When the longitudinal axis of the *Sergeant* forms an angle of 75° to the horizontal, the missile battery is activated and the countdown proceeds. Deflector plates ensure that the launcher is not damaged during firing.



A Douglas engineer has said that the only new condition imposed on inertial guidance is associated with the requirements for determining position and velocity at launch. While new to inertial systems, this is not new to designers of bombing and navigation equipment for aircraft.

For a successful launch, the *Skybolt* computer requires altitude, velocity and azimuth information. The first two are provided by the standard B-52 bomb-navigation system, while a star tracker mounted directly upon the stable reference platform of the missile will provide azimuth checks for periodic correction of the inertial guidance system (the star tracker is expended with each launching).

Because its range is only 1,000 nautical miles, the *Skybolt* does not have as strenuous a guidance requirement as an ICBM which covers 5,500 nautical miles. An azimuth fix of about 3 minutes of arc is considered sufficient, while position need not be fixed more precisely than 2,000 ft on the earth's surface to permit a successful strike. In operation it is planned that the launching aircraft will be flown to a selected reference point with landmarks clearly apparent to a radar navigation system; at this point the missile will be zeroed with the required information and will be launched as quickly as possible.

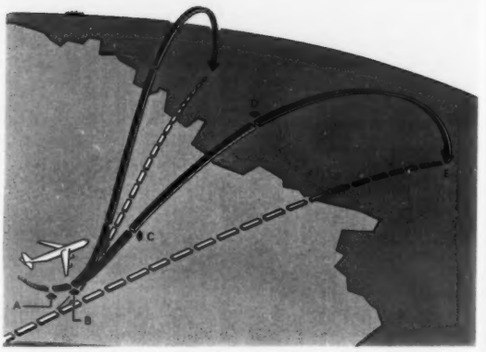
Although the guidance problem is not as acute as it might appear at first glance, other phases of the *Skybolt* programme will present problems. Chief amongst these is the fact that the missile will have to live in an environment covering a 7-day period slung beneath the wing of a B-52 at temperatures ranging from upwards of 100°F at desert airfields, to −65°F in the space of 35 minutes when a mission is called. It will also have to absorb a high degree of vibration during the course of a 6 to 8-hour flight to the release point. The Air Force and Douglas believe that all these problems can be solved with existing propellants and case materials, with only slight modification.

The size, weight and external configuration of the missile are still classified, but it is learned that it will incorporate a single swivelling nozzle in each of its two stages, plus small motors to control rolling moments (the original planning called for multiple nozzles in each stage). Blow-out plugs on the second stage will provide velocity control by terminating the thrust of the motor.

*

Douglas and its subcontractors have already completed the following work on the development programme: system configuration determination, missile mockup, aircraft missile integration mockup and engine tests. The remaining "milestones" are guidance sled tests, dummy drop tests, captive missile tests, programme flight tests and guided flight tests. Major subcontractors for the *Skybolt* are Aerojet-General (solid-propellant motors), General Electric (re-entry vehicle) and Northrop Nortronics Division (guidance system). Nortronics, in turn, obtains miniaturized accelerometers for the guidance system from Bell Aerosystems.

For automatic checkout of the missile and its ten sub-systems, the U.S. Air Force has



A Douglas *Skybolt* mission: At (A) the carrier aircraft releases the weapon, whose first stage motor ignites a few instants later. At (B) the *Skybolt* noses up, at (C) the second stage motor ignites, and at (D) the re-entry body containing the warhead is separated. Impact takes place some 1,000 nautical miles from the point of launch. If the target is not directly in line with the aircraft's direction of flight, range is slightly reduced.

adopted the PC-300 equipment developed by Bendix Support Equipment, of Teterboro, New Jersey. Basically, the PC-300 is a transistorized computer which takes its instructions from a taped programme and can be used, with the appropriate adaptor, to control the test programme for sub-systems of any kind. It has been developed from the B-58 *Hustler* flight control and air data systems checkout equipment. The first production model is scheduled for delivery to the Air Force in January 1961. Main contractor for the equipment to be used by the RAF will probably be Bendix-Ericsson (U.K.) Ltd., a new company recently formed in London. Basic price of each set of equipment is $80,000.

Sergeant — the U.S. Army's new tactical missile

A member of the U.S. Army's second generation of tactical missiles, the Sperry *Sergeant* replaces the Firestone *Corporal,* which has been in service for the past four years. The new surface-to-surface weapon requires little more equipment or training than a big gun. Each *Sergeant* is associated with four cross-country vehicles, and a mobile test and servicing workshop is required for each group of rockets. The accompanying pictures show how easily and quickly the missile is assembled and fired.

Developed by the California Institute of Technology's Jet Propulsion Laboratory for the U.S. Army's Strategic Army Command, the *Sergeant* is produced in quantity by the Surface Armament Division of Sperry Gyroscope Company at Salt Lake City, Utah. Sperry is also responsible for the inertial guidance system. The solid-propellant motor (50,000 lb thrust) is supplied by Thiokol Chemical Corporation and accelerates the rocket to a speed equivalent to Mach 3.5. Length of the missile is 35 ft, diameter 31 in., weight 10,000 lb, and range 100 miles.

Atlas-Centaur

The *Atlas-Centaur* booster vehicle, the first to use liquid hydrogen and liquid oxygen as propellants, is being developed under the direction of the National Aeronautics and Space Administration for research in the inner solar system. First flight tests are scheduled

for the first quarter of 1961; planetoid launchings are due in 1962, and the *Atlas-Centaur* will lift the *Surveyor* spacecraft for a soft landing on the moon in 1963. In addition it can place a 4.5-ton payload into a low satellite orbit. The *Centaur* second stage is also used as stage S-5 for the *Saturn* booster, and its motors will power the S-4 stage of *Saturn*. Finally, NASA is investigating the possibility of using *Atlas-Centaur* for manned space travel.

The airframe of *Atlas-Centaur* is being developed for NASA by the Convair (Astronautics) Division of General Dynamics Corporation; the three power units for the first stage (two LR-93s and one LR-105), with a total thrust of 360,000 lb, are supplied by the Rocketdyne Division of North American Aviation; and Pratt & Whitney is responsible for the two motors for stage two (LR-115s), which deliver a total thrust of 30,000 lb. Krafft A. Ehricke is in charge of *Centaur* development at Convair.

Description: The first stage of the *Atlas-Centaur* is formed by a modified *Atlas D* intercontinental missile, as developed by Convair for the U.S. Air Force. Unlike the operational missile, the airframe is not conical at the tip, but has a diameter of 10 ft to take the *Centaur* second stage. Like the *Atlas* first stage, the *Centaur* will also be constructed of thin stainless steel. It has no internal stiffening and will be slightly pressurized to maintain its shape. As the same tooling can be used as for *Atlas* production, manufacturing costs can be kept to a reasonable level. The 18-ft nose cone is made of heat-resistant plastic (cf. *Interavia* No. 9, 1960, p. 1141). Overall length of the *Atlas-Centaur* is 107 ft 8 in.

Guidance: The *Centaur* second stage is controlled in flight by an inertial guidance system, developed by Minneapolis Honeywell Regulator Company under contract to Convair. The system includes a multi-purpose computer, which receives and stores information on attitude and speed of the rocket from the accelerometers mounted on a gyro platform. If attitude and speed changes are required, the computer passes an electronic signal to the autopilot, which then undertakes the appropriate change in thrust vector.

Structure of the *Atlas-Centaur*: bottom, the rear of the *Atlas* first stage with booster motors; centre, the *Atlas* first stage containing the sustainer motor; top, the *Centaur* second stage.

Flight sequence: In a typical flight by the *Atlas-Centaur*, the two booster motors, the sustainer powerplant and the two small vernier rockets in the first stage are ignited simultaneously. After a few minutes, the rocket tail containing the booster motors drops off, and the vehicle is propelled by the sustainer motor alone. At burnout of the first stage, the rocket has achieved a speed of roughly 10,000 m.p.h. Separation of the second stage is actuated by four small auxiliary rockets, while retro rockets on the first stage cause the latter to fall behind the *Centaur* stage. For most missions the *Centaur* engines will probably be cut off after a pre-determined time, then re-ignited after a period of coasting. Present plans call for two re-ignitions.

Testing: The *Atlas-Centaur* will be launched from the Convair-designed Station 36 at the Atlantic Missile Range, Cape Canaveral. This is adjacent to Station 11 (Atlas testing). For captive tests, Convair has added a new stand to the *Atlas* test facilities at Sycamore Canyon, near San Diego. Finally, the *Centaur* engines are to make a number of test runs at Edwards AFB, California, where Convair has stationed 300 technicians for its ICBM programme.

New low-cost weather sounding rocket, designed by the Rocketdyne Division of North American Aviation. The rocket uses solid propellants, and its motor produces a thrust of 660 lb for approximately 13 seconds. The device is designed to propel a 6-lb payload to an altitude of 230,000 ft. The body itself is 4 in. in diameter and 105 in. long including payload.

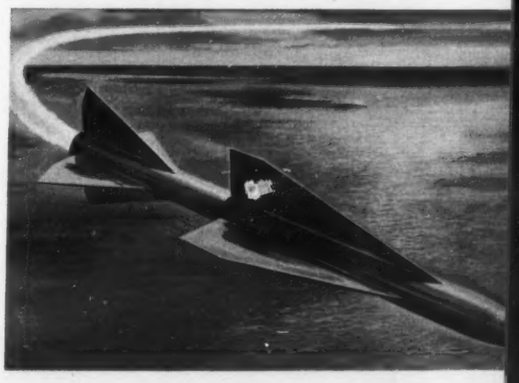
Redhead-Roadrunner target missile

The Columbus Division of North American Inc. has received a $3,940,581 contract from the U.S. Army as prime contractor for the new *Redhead-Roadrunner* target missile. The drone can be used for either high or low level missions. For low-level flight, it will be controlled by all-movable surfaces mounted at the rear of the body. For high-altitude supersonic flights, small triangular wings will be attached to provide additional manoeuvrability. The drone can operate at speeds up to Mach 2 and at altitudes up to 50,000 ft. It will be ground launched by a booster located under the fuselage, and powered in flight by a Marquardt ramjet. Length of the missile is less than 19 ft, diameter of the body 1 ft. The removable wings will have a span of approximately 6 ft, and the twin stabilizers a span of approximately 3.5 ft. →→

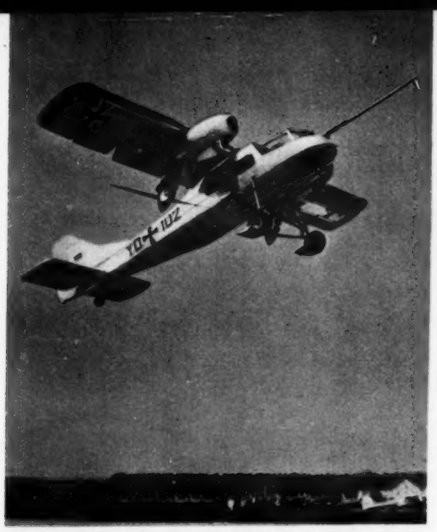
The North American *Redhead-Roadrunner* target missile is powered by a Rocketdyne solid-propellant booster (6,000 lb thrust) during the launching phase and by a Marquardt ramjet during sustained flight.

Drawing of an atomic bomb-proof launching silo for the Martin TM-76B *Mace* tactical surface-to-surface missile (one Allison J33-A-41 jet engine of 6,000 lb thrust; one Thiokol solid-propellant booster of 100,000 lb thrust). Simulated zero-length launches from silos have been carried out at Holloman AFB, New Mexico, and further tests are to be made at Cape Canaveral. The *Mace*, which can carry a normal or atomic warhead over a range of roughly 1,100 miles, is destined for units in Western Europe and the Pacific region.

Drawing of the Bendix AAM-N-10 *Eagle* air-to-air missile. The weapon, which is powered by an Aerojet-General solid-propellant motor, weighs 2,000 lb, measures roughly 15 ft in length and reaches speeds corresponding to Mach 4. Grumman has received an $8.4 million contract for production of *Eagle* airframes and maintenance equipment and the conversion of an experimental carrier aircraft. Ultimate operational carrier for the *Eagle* will be the *Missileer* now under development at Douglas.



What's in the Air?



Two prototypes of the Do 29 experimental STOL aircraft have been undergoing tests at the Dornier plant for the past year or more. A detailed description of this aircraft is scheduled for a forthcoming issue of Interavia.

AIR TRANSPORTATION

The Federal Aviation Agency has invited Canada, Ireland, Portugal and the United Kingdom to join in a twelve-month air traffic survey aimed at more efficient use of North Atlantic airspace under jet travel conditions. FAA's Bureau of Air Traffic Management has sent Commander Clinton H. Mundt to discuss the plan with the air departments of the other governments and to visit traffic control centres in the Atlantic area.

Meanwhile, at home, FAA plans a $163,250,000 expansion of the U.S. air navigation and traffic control systems in the year ending June 30th, 1961. The improvements will include radar, control towers, radio communications, improved teletype service, instrument landing systems and high intensity approach lighting, and nine new control centres averaging $1.9 million each. This is FAA's largest single expansion programme.

Great Britain and Hungary have concluded a civil aviation agreement providing for scheduled services between London and Budapest. BEA hopes to begin operations to Budapest next April. Malev will probably operate into London with Il-14s or Il-18s.

British European Airways and Aeroflot have signed a new agreement for London–Moscow services. BEA operates two *Comet 4* services from London each week, and Aeroflot operates two Tu-104 services. From May 1961 frequency will be stepped up to three round trip flights a week by each carrier.

A Netherlands delegation signed a bilateral agreement with Jordan in late October, covering scheduled air service between and through the two countries. KLM currently operates a once-weekly Lockheed *Electra* service to Amman (from Amsterdam via Vienna-Istanbul-Beirut) under special permission from Jordan.

Japanese spokesmen say that negotiations are progressing smoothly with Britain, West Germany and Italy on landing rights for Japan Air Lines' projected new services to Europe via the polar and southern routes next year. The head of the Transport Ministry's Civil Aviation Bureau says that JAL could inaugurate DC-8 service via the polar route by about June 1961, and a Convair 880 service on the southern route by the end of 1961, after conclusion of aviation agreements with the three countries. A commercial air agreement with West Germany is virtually completed, he added. JAL's polar route to Europe will be operated from Tokyo to London via Copenhagen or Hamburg, not via Ireland as originally proposed. The southern route will be via Frankfurt or Düsseldorf and Paris to London.

Prime Minister Nehru of India stepping from the cabin of a Sikorsky S-62 helicopter, the first of two ordered by the Indian Air Force. An S-62 has also been delivered to Los Angeles Airways.

Meanwhile, on the other side of the world, Japan Air Lines has been talking to the Indonesian authorities on a possible service to Djakarta, which the company would like to start by mid-1961.

Total air passengers to and from the United Kingdom in the first six months of 1960 for the first time exceeded the number of sea passengers, according to the Board of Trade Journal. Air Traffic was up 26 percent to 1,282,000 arrivals and 1,268,000 departures, compared with 1,222,000 arrivals and 1,207,000 departures by sea (up 2 percent).

West Germany's ten civil airports recorded 3,080,000 passenger arrivals and departures during the first half of 1960, a 27.5 percent increase on the 1959 six-month figure. Freight was up 25 percent, and mail 22 percent.

All IATA airline services to Rome are now using the new Leonardo da Vinci Airport at Fiumicino.

The Surinam Government has set up a committee to study the question of a projected joint Netherlands-Netherlands West Indies–Surinam airline. The move is being interpreted as a sign that KLM's Caribbean Division may be transferred to other hands, with the financial support of the Surinam Government; this would go some way to solving the problem of the unprofitable KLM Caribbean regional operation.

Air-India International is preparing to inaugurate a scheduled weekly jet service between Bombay and Tokyo via Hong Kong and Bangkok early next year, replacing one of the current three Lockheed Super Constellation flights by a Boeing 707 flight. The carrier will eventually replace all piston-engine aircraft on the route with jets.

Design for the $8 million new terminal building at San Francisco International Airport. The terminal will be the first element to be constructed in the master plan for the airport prepared by the architects Welton Becket and Associates and adopted by the San Francisco authorities in February 1959.

INDUSTRY

The West German Defence Ministry is expected to announce a new order for a further batch (probably about 40) of U.S.-manufactured Lockheed F-104Gs, bringing the total on order from the States up to about 100. The new order may possibly include some additional F-104Fs.

International General Electric Company, a division of General Electric, has received a $13.5 million contract for J79 jet engine components for assembly in West Germany and Belgium. Raw materials, forgings, castings and semi-finished parts will go to BMW Triebwerkbau in West Germany to complete the first phase of long-term production for approximately 600 engines for the F-104G *Starfighter*. In this first phase BMW will build an initial 96 engines under a licensing agreement with General Electric via the West German Government. The Belgian F.N. company (Fabrique Nationale d'Armes de Guerre) will construct a further 82 under a direct arrangement with General Electric. Delivery of the components will begin in early 1961, with the present supply contract running until 1962. In a joint manufacturing effort BMW and F.N. will supply each other with semi-finished components.

Exploratory discussions concerning Fiat participation in the European J79 have been held in Munich with BMW, and General Electric has also been

discussing possible conditions in Italy. A Bonn report indicates a proposal to set up a new company (possibly in Bonn) to handle the entire European J79 contracts and to coordinate subcontract work.

U.S. Science GmbH is the name of a new West German subsidiary of U.S. Science Corporation, Los Angeles, with offices at Düsseldorf. The company will manufacture and sell electronic aircraft control equipment, including angle of attack sensors and indicators, and stick shakers.

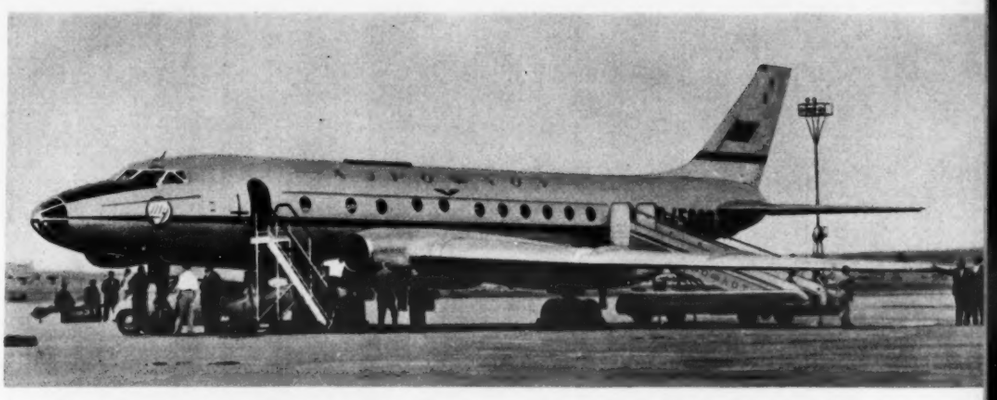
Elliott Brothers (London) Ltd., subsidiary of Elliott-Automation Ltd., and FXR Inc., of Woodside, N.Y., have signed an agreement to manufacture and sell each other's range of microwave instruments. The Elliott territory includes the whole of the British Commonwealth, except Canada; FXR Inc. covers the United States and Canada. FXR has developed a range of microwave laboratory instruments covering the frequency bands from 350 to 220,000 Mc/s. Elliott has developed advanced techniques of instrument manufacture mainly for applications in laboratory equipment for the frequency bands 7,000 to 75,000 Mc/s.

The de Havilland Aircraft Company of South Africa (Pty) Ltd. has been renamed **Hawker de Havilland (Pty) Ltd.** and will be responsible for the distribution of all Hawker Siddeley Group products in southern, central and east Africa. The new company will represent Air Service Training, Armstrong Whitworth Aircraft, Folland Aircraft, Blackburn Aircraft, de Havilland Aircraft, Gloster Aircraft, Hawker Aircraft, A.V. Roe and Westland Aircraft. The Hawker Siddeley Group was previously represented in South Africa by Atalanta Industries.

The National Aeronautics and Space Administration has selected Aerojet-General Corporation, Grand Central Rocket Company and Thiokol Corporation to carry out 6-month design studies on extremely large solid-propellant booster rockets. The boosters will weigh from 1 to 7 million pounds, with thrust ratings from two to three times their weight. Grand Central will work at the lower end of the scale, with Aerojet studying intermediate weight ranges, and Thiokol at the top of the scale.

Model of the projected Boeing 731 turbine-powered passenger and cargo transport, which may be considered under the Military Air Transport Service's procurement plans. MATS expects to spend a total of $2,000 million for the procurement of urgently required jet transports during the next eight years. In this fiscal year alone, nearly $250 million have been earmarked for the purchase of turbine-powered aircraft and to begin development of a troop transport powered by turbofan engines.

The Autonetics Division of North American Aviation has received "multi-million" dollar contracts from the Canadian Government and Lockheed for R24A/B NASARR (North American Search and Range Radar) systems to equip the RCAF's CF-104 fighter-bombers and CF-104D trainers. The two Lockheed contracts cover engineering and manufacturing of three R24A prototypes and 14 production R24Bs. The Canadian Government order calls for 19 production R24As. Autonetics has also signed a technical assistance agreement with the Canadian Government which will enable Canadian Westinghouse, of Hamilton, Ontario, to manufacture the equipment under licence, with design information and technical support provided by the American company.



The Tupolev Tu-124 short- to medium-range airliner, fitted with two Soloviev by-pass engines of undisclosed power. Maximum speed is reported to be around 500 knots, and mean range some 800 nautical miles. The cabin can be equipped to carry 44 first-class, 55 to 60 tourist-class or 68 economy-class passengers.

Douglas Aircraft Company has received a $60 million contract from Bell Telephone Laboratories as its share of the U.S. Army's $199,125,000 supplemental contract for continued research and development of the *Nike-Zeus* anti-missile missile for a further twelve months. Western Electric (prime contractor) and Bell Telephone Laboratories (research and development responsibility) received the Army contract early in October (as reported in the November issue of *Interavia*). The Douglas portion of the programme includes development of the missile itself and related handling, testing and firing equipment.

Lockheed Missiles and Space Division has been awarded an additional U.S. Navy contract worth $181 million to accelerate development of a longer-range *Polaris* missile (2,500 nautical miles, compared with the present 1,200 nautical miles). The range increase will be made in two steps, from 1,200 to 1,500 nautical miles, and then up to 2,500 nautical miles. The Navy would like to arm 45 *Polaris*-carrying submarines (16 missiles each) as well as offer an additional 300 missiles to NATO nations for deployment. Cost of the complete programme is estimated at $8,600 million, including $2,000 million for research and development. The latest contract brings the total so far engaged for the *Polaris* programme to approximately $608 million, excluding research and development costs.

Sperry Gyroscope Company has received a Convair contract valued at over $30 million for additional production of navigation-bombing systems for the B-58 *Hustler*. The Sperry system is completely automatic and employs doppler and inertial navigation techniques to ensure both long and short distance accuracy. The equipment was designed to control the launching of an air-to-surface missile and can be modified to control the launching of an ALBM.

Minister of Aviation Peter Thorneycroft has announced that the British Aircraft Corporation is to get a £350,000 contract to undertake further work on a limited design study for a possible supersonic airliner project. A formal contract is being negotiated. BAC has been asked to explore the possibilities of collaboration with appropriate foreign companies with a view to sharing costs and widening the market for the product. Sir George Edwards, Executive Director (Aircraft) of BAC, states that he favours the early development of a Mach 2.2 (1,500 m.p.h.) airliner, rather than a Mach 3 project. Neither the United States nor the United Kingdom, he said, knew how to build a 2,000 m.p.h. transport, and he doubted whether the airlines would be able to absorb anything more than a 1,500 m.p.h. aircraft or whether such an aircraft would be safe enough to carry passengers before the 1970s. The development cost of the project would be between £50 and £100 million.

AIRCRAFT AND ENGINES

A total of 116 Kaman H-43B Huskie turbine-powered helicopters will be delivered to the U.S. Air Force under existing contracts, for use primarily in local base crash-rescue missions. The helicopter is powered by one Lycoming T53-L-1 gas turbine, with a military rating of 860 s.h.p. and a normal rated power of 770 s.h.p.; normal cruising speed is 95 knots.

The SAAC.23 executive aircraft, certification of which was recently discussed between representatives of the Swiss Federal Air Office, the Swiss-American Air-

The first three of the Sud-Aviation Caravelle VIs *ordered by Sabena are nearing completion. They are due to fly in mid-December.*

Four Convair B-58 Hustler *supersonic bombers are being converted for the training role. Picture right shows one of the first TB-58 trainers on touchdown. Main external difference compared with the original bomber model is the addition of extra cabin windows to improve visibility for the instructor. Left-hand pictures: a B-58* Hustler *bomber with radar-controlled General Electric* Vulcan *20-mm cannon in the tail. Rate of fire of the six-barrel cannon is 6,000 rounds per minute.*

craft Corporation and the U.S. Federal Aviation Agency, has a low-set wing with a span of 35 ft 4 in. and two jet engines at the rear of the fuselage. Most likely engine choice is the General Electric CJ610. The 7-seat aircraft will have a maximum speed of around 530 knots and a range of about 870 nautical miles, or 1,650 nautical miles with auxiliary fuel tanks. Take-off and landing distance is given as approximately 1,700 ft.

effluxes on the fuselage sides under each wing delivering cold air and hot gas respectively from the BS.53 engine. The high-wing P.1127 also has large air intakes on either side of the fuselage. Other characteristics: tandem undercarriage with wing-tip outriggers; fin slightly swept back; stabilizer on the underside of the fuselage rear.

The North American T-39 Sabreliner trainer and multi-purpose aircraft is in production in several versions, including the T-39B (production aircraft Nos. 6 to 11) which will carry complex radar equipment and be used primarily for pilot training. In addition a T-39C version is under development (for radar counter measures and training).

A new runway sweeper has been brought onto the market by AB Åsbrink, of Malmö, Sweden. Swept width is 150 in. with side brushes, or 102 in. without; hopper capacity 106 cu.ft. The sweeper can be used with any type of towing vehicle with a load capacity of at least 3 tons.

The Dassault Mirage III fighter's first production model began flight testing at Bordeaux–Mérignac on October 19th, 1960.

The Hawker P.1127 VTOL strike aircraft began hovering tests at Dunsfold, Surrey, on October 21st, 1960. An undisclosed number of P.1127s has been ordered by the Ministry of Aviation; a second model will be completed in a few months' time. Hovering rials are being carried out in a special tethered rig.

Although the manufacturers had still released no details of this aircraft at the time of writing, it is common knowledge in Europe that the P.1127 is a single-seater with single fin and rudder, and twin

The Douglas DC-7, DC-7B and DC-7C could, D. Napier & Son proposes, be converted to the *Eland* propeller turbine and offered for long-range passenger and freight transport on the American market. Reports indicate that the converted DC-7s and DC-7Bs would operate at a gross weight of 126,000 lb, the DC-7C at a gross weight of 143,000 lb. The minimum runway lengths for their weights would be 5,800 ft for the DC-7 and DC-7B, and 6,000 ft for the DC-7C.

The 4/5-seat Czechoslovak HC-3 helicopter, derived from the two-seat HC-2, is powered by a 240 h.p. M-108H six-cylinder engine. It has an all-up weight of about 2,900 lb, a maximum speed of about 90 knots and a maximum hovering ceiling of around 3,000 ft.

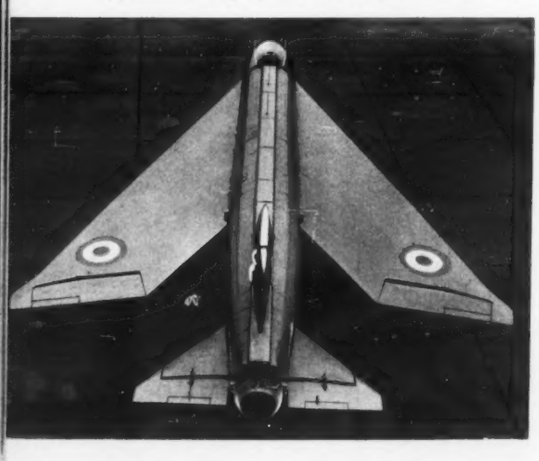
The TS-11 Iskra two-seat jet trainer, based on a design by Polish Engineer Tadeusz Soltyk, has now begun flight testing. It is powered by a small jet engine of Polish design, on which, however, no information has been released. The TS-11 has a maximum speed of around 460 knots and a ceiling of some 36,000 ft.

The Omega BS-12D1 helicopter, in production at the Omega Aircraft Corporation's New Bedford, Mass., plant, has been granted provisional FAA certification. The 12D1 model is powered by two 235 h.p. Lycoming O-540-F1B5 piston engines, though another version, the BS-12E, is being offered with 225 h.p. Franklin 6AS-335 supercharged engines.

Sud-Aviation is building two pre-production models of the SA.3210 *Frelon* helicopter, which are due for delivery at the end of 1962. The SA.3210 is an advanced model of the SA.3200, the two prototypes of which have been undergoing flight tests for the past year or more. The pre-production models are fitted with more powerful Turboméca *Turmo IIIC* turbines of roughly 1,300 h.p. each. Gross weight is around 10 tons. All three French armed services are showing interest in the SA.3210, and there appears to be some chance that the helicopter will be produced in quantity; in this case deliveries could begin during 1964.

The new Boeing 502-10W propeller turbine is undergoing bench tests in preparation for FAA certification tests. For the present series of trials, the engine is equipped with an 84-inch diameter Hartzell three-blade variable-pitch, fully reversing and feathering propeller. Power is 325 s.h.p. at 2,600 r.p.m. propeller shaft speed; normal continuous rating is 270 s.h.p. The same new test stand will also be used for development work on Boeing's 475 s.h.p. Type 520-4 turboprop engine, which is scheduled to begin certification testing before the end of the year.

Flight testing of the Short SB.5 variable-wing research aircraft has been resumed, with the wing now set at a sweepback of 69°. This follows earlier tests with an angle of sweep of 50° and 60°. The object of the SB.5 is to investigate wing configurations for high-speed aircraft, in particular at the relatively low speeds involved during the take-off and landing phase.



The U.S. Navy designation of the 500 s.h.p. Continental 217-5A is T72-T-2. The engine is to begin flight tests in April, 1961. Continental is also developing a turboprop version, manufacturer's designation 217-6A.

Klöckner-Humboldt-Deutz AG is preparing for licence production of the Bristol Siddeley *Orpheus* jet engine at its Oberursel plant in the Taunus hills north of Frankfurt. The gas turbine development department at the plant, which is working on turbo superchargers and gas turbines, is also being expanded. The T 16 small gas turbine is at present under development and is designed for use as a power unit for fire fighting trucks, air compressors and small boats. It is described as a light, simple and robust unit with a rating of 80 h.p. (100 h.p. in a later version). It weighs 139 lb and in its present basic form can operate at angles of inclination of up to 30°. With the use of the proper oils and fuels, it can be started by one man at temperatures of down to -40°C. The following fuels can be used: diesel oil, light heating oils, kerosene or petroleum. ⟷

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PIPER AZTEC

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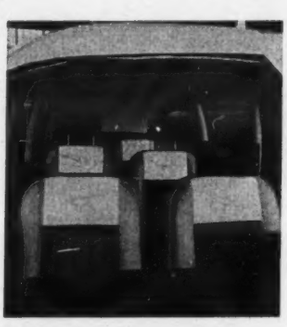
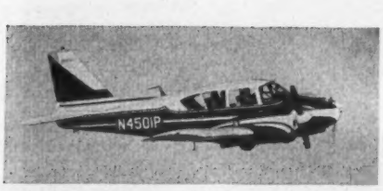
FAST... Aztec's jet-type "flying tail" adds speed, stability.



ROOMY... Five ride in roomy luxury, with ample allowance for baggage.

The Piper Aztec, newest, largest, fastest aircraft to join the Piper fleet, is an over-200-mph (320-kph) twin powered by two 250 hp Lycoming engines. The Aztec carries a useful load of *over one ton* (over 900 kgs) ... takes off in less space, lands in less space and has a higher single-engine ceiling than any other twin-engine airplane in its class carrying a similar payload. With full 144-gallon (544-litre) standard fuel, five 170-pound (77-kg.) passengers, full radio and instrumentation for instrument flight, the Aztec cruises 205 mph (330 kph) at 7,000 feet (2,100 metres) (75% power) and has range of over five hours. Piper production efficiency permits the Aztec, fully equipped, to be priced well below any other twin in its class.



EFFICIENT... Piper Aztec has highest single-engine ceiling of any plane in its class carrying similar payload.

AZTEC SPECIFICATIONS

Engines (2)	Lycoming O-540	
Horsepower and RPM	250 at 2575	
Gross Weight	(lbs) 4800	(kgs) 2177
Empty Weight	(lbs) 2775	(kgs) 1259
Useful Load	(lbs) 2025	(kgs) 918
Top Speed	(mph) 215	(kph) 346
Cruising Speed (at 7000 ft)	-205 mph	(at 2134 met)-330 kph
Stalling Speed	(mph) 62	(kph) 100
Rate of Climb	(fpm) 1650	(mpm) 503
Service Ceiling (ft)	22,500	(met) 6,858
Absolute Ceiling (ft)	23,750	(met) 7,239
Fuel Consumption	(gph) 28	(lph) 106
Max. Range with Standard Fuel	(miles) 1,400	(km) 2,253

PIPER

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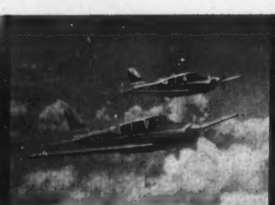
APACHE. Four or five passenger twin, cruises 171 mph (275 kph). Most economical to buy and fly.



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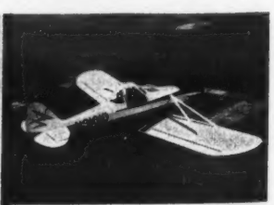
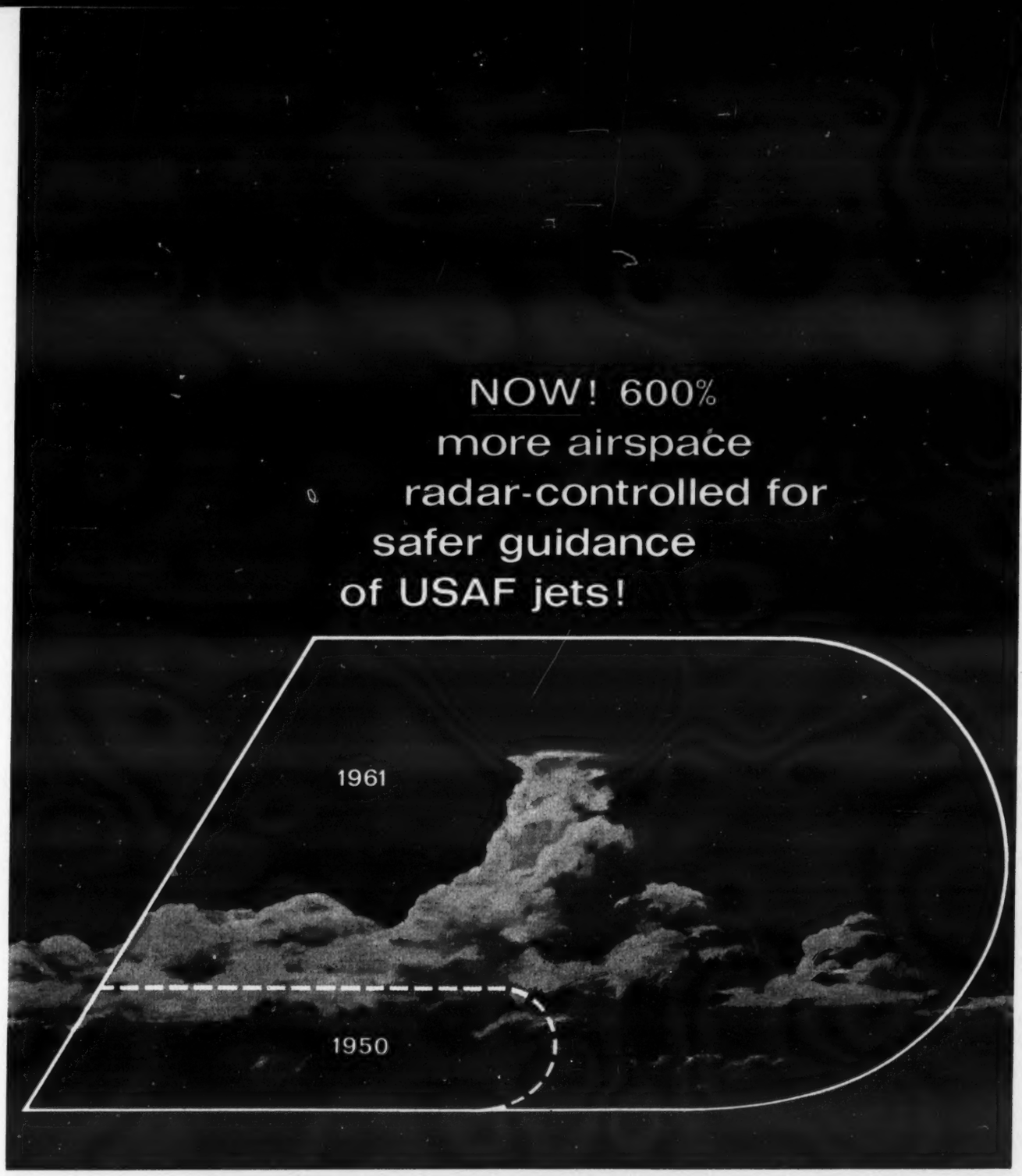
SUPER CUB. World-famous utility plane, with short, rough field, high altitude capability.



PAWNEE. New agricultural plane for efficient dispersal of dust or spray.



600% more coverage at 2% of cost

Gilfillan has been selected to up-date USAF worldwide GCA network. Now under way, Gilfillan field modifications of 183 USAF GCA systems. Provides, *immediately,* the expanded area of control vital for safer guidance of high performance jets–*at less than 2% of the cost* of replacing these *proven* GCA systems. The low cost *on-site* modifications accomplish the following:

Radar altitude coverage, the most critical factor in jet guidance, is increased more than 400%. Range coverage is extended 50%. Total expansion in radar-controlled airspace, 600%.

Gilfillan
LOS ANGELES

By our standards the best magnetic compass is just an old lode-stone

If you were at the bottom of a mine-shaft, or in unsurveyed country on a cloudy day, and you had to find true North with high precision, we could help you. We wouldn't use a magnetic compass, which is hopelessly crude, or the Astronomer Royal, who would insist on having a clear view of the sky. We would use one of our fantastically accurate and sensitive Floated Gyroscopes. And the job would be done to an accuracy of a few minutes of arc.

This is but one of the several complete systems we are working on, taking as our starting point the Gyroscopes we make in partnership with Minneapolis-Honeywell and grafting on to them all the arts and skills of the computor designer and the electronics engineer. And we believe we've only scratched the surface of the capabilities and versatilities of Gyroscopes so accurate that they precess barely a degree per *day*, and so sensitive that they respond to a rate of rotation of one revolution in many *years*.

Have you got a problem of this nature which seems to you impossible ?

'ENGLISH ELECTRIC'
INERTIAL GUIDANCE

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No more limitations
COMPLETE FREEDOM OF DESIGN...

Nicht mehr gebunden sein
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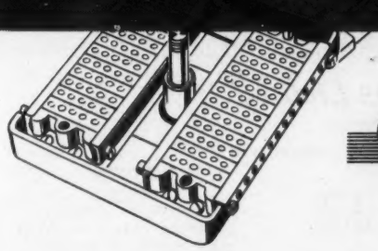

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Rangatai, Wellington, New Zealand.
R.R.A.F. Southern Rhodesia.
R.A.E. Bedford, England.

STC Precision Approach Radar *type SLA 3B2*

In addition, this equipment has been ordered for Whenuapai, Auckland, New Zealand. R.N.Z.A.F. Ohakea, New Zealand.
A Mobile Version (SLA 3B1) is in Quantity Production for The Royal Air Force.

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ORIGINAL EQUIPMENT ON THE FOKKER Friendship

From Ireland to Australia, from Alaska to Iran, the twin engine turboprop F-27 " Friendship " makes new friends daily. The comfort, speed and reliability of this trim, medium-sized airliner have been widely recognized since its introduction in 1955, and it is becoming increasingly popular for commercial passenger and private industrial purposes.

Contributing to the dependability, and the safety, of the F-27 is the superior quality Autolite wire used in the plane's electrical systems. Autolite Type B-1 Cable, used by Fokker in the " Friendship " series, **exceeds** the basic Military Specifications of the United States Government.

This wire, like all Auto-Lite Aircraft and Electronic Wire, **guarantees lightest weight** and **smallest uniform diameter.** Like all Autolite Wire, it is resistant to abrasion, solvents and impact . . . will not support fungus growth . . . is **definitely** flame resistant. Rigorous and continuous performance tests give all Autolite Aircraft Wire high ratings for temperature stability and for cold flexibility.

Autolite Wire has been selected by manufacturers as original equipment in propellor driven, turboprop and jet aircraft for power and lighting circuits, relays and various electrical connections. It is widely used, also for maintenance and modification work.

From two modern plants, both recognized on Government Qualified Products Lists, Auto-Lite supplies wire to airframe makers, airlines and Government agencies all over the world, as well as to numerous divisions of the United States Department of Defense.

Specification MIL-W-5086A, Type II, B-1

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A light-weight, flexible, small-diameter low tension wire. Conductor of tinned copper strands, insulated with PVC, designed for general aircraft use up to 600 volts and at continuous conductor temperatures up to 105° C. White, with close-weave white glass braid plus clear extruded nylon jacket. Available in sizes 22 through 12. Also offered in Shielded version (MIL-C-7078A) below with closely-woven tinned-copper shield over basic wire.

Type I, III and other Type II wires in this same Military Specification Series are also available in sizes 22 through 0000.

Specification MIL-C-7078A, Type II, B-1

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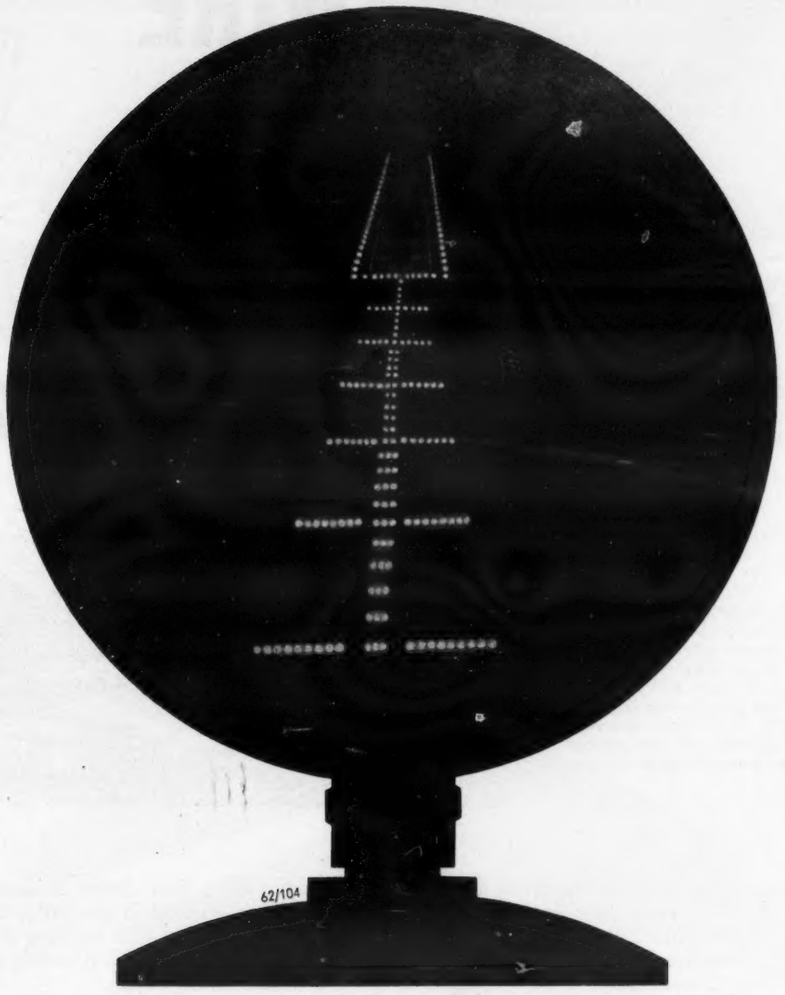
SIEMENS



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BERLIN · ERLANGEN

INTERKAMA

Düsseldorf, October 19th to 26th, 1960

Advances in measuring techniques and automation have continued at such a pace during the past three years that this year's INTERKAMA (International Congress and Exhibition for Instrumentation and Automation) was awaited with considerable, and justified, interest. Having been accepted into the Union des Foires Internationales (the international association of recognized trade fairs), this exhibition, which is unanimously agreed to be the biggest and most important of its kind at any rate in Europe, has won world-wide recognition.

The some 110,000 visitors were offered a comprehensive programme: 470 companies (including 188 from outside Germany) put their wares on show in five exhibition halls, 7,520 persons attended the 46 lectures held during the Congress, and 53 companies organized a total of 252 instrumentation courses.

The organizers succeeded fully in the task they had set themselves: INTERKAMA 1960 provided an overall view of the present status of measuring and control techniques and offered much valuable stimulus for the practical engineer. All participants were particularly appreciative of the fact that visitors were not only able to inform themselves on the present-day situation, but also that there was ample opportunity for detailed technical discussion between manufacturers and users. Many companies, for example, sent whole teams of technicians and scientists to Düsseldorf to discuss with the experts from the automation industry the problems which had arisen in their own firms.

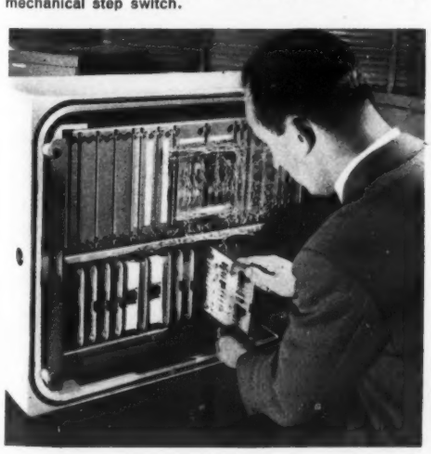
INTERKAMA 1960 proved that the targets set three years ago have in large part been met—and also that developments in this relatively new field of activity are going ahead as rapidly as ever. The use of transistors and semi-conductors, the miniaturization of components and the employment of printed circuits have been adopted in all branches of measuring and control techniques. Today measurements can be made, with the aid of radio-active isotopes, without interrupting the course of a process, and instrumentation and automation have received an undeniable impulse from the many new problems that have had to be solved in the growth of nucleonics.

Two particular development trends could be discerned: the advance of the building-block principle and the increasing use of electronic computers. Instead of building bulky and costly universal equipments capable of handling many different tasks, the present trend is to construct a basic unit and add a series of accessories, each designed for a specific purpose. Systems of this kind are offered in large numbers, and the developing international standardization will make it possible to combine components from several different manufacturers to form the equipment exactly suited to any given requirement.

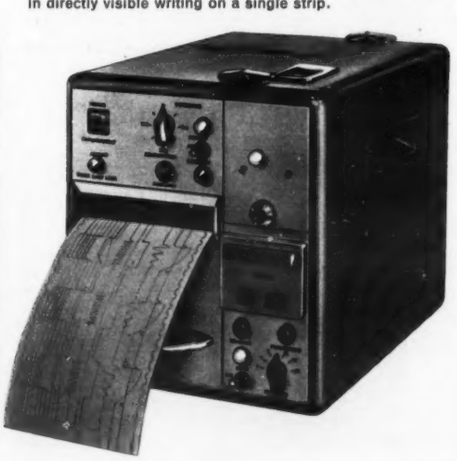
The second trend—growing use of electronic computers—can be seen above all in control techniques. The first signs of this development were apparent at INTERKAMA 1957. Today whole series of components are already available for this purpose, and together with the rising technique of digital measurements the use of electronic computers should contribute to the solution of many particularly complicated control problems.

What of the future? Here, too, INTERKAMA 1960 provided several pointers: continued development of existing systems and components; extensive use of compensation methods in measuring techniques; greater emphasis on the unit principle for building up equipments; and above all the development of new methods of optimization. *In brief: measuring and control will become still more accurate, faster and cheaper.*

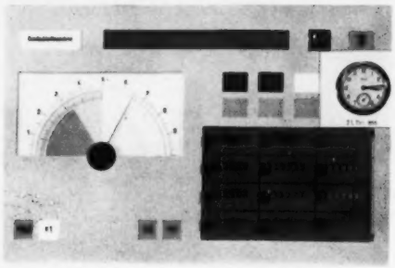
● **De Havilland Propellers Ltd., Hatfield, England,** has followed a new line of development in the *Anatrol* computer, offering a complete and versatile analogue computer for a wide range of applications at a relatively low price. The number of components is reduced to a minimum, and the computing operations are carried out step by step to a set programme with the aid of a memory and an electro-mechanical step switch.



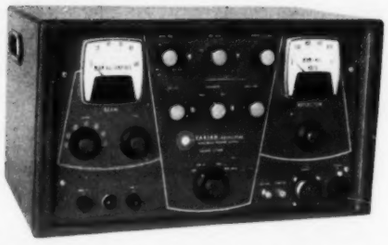
● **Hartmann und Braun AG, Frankfurt, Germany,** showed a range of equipment, including a new version of the *Lumiscript* recorder which records up to 50 parameters in directly visible writing on a single strip.



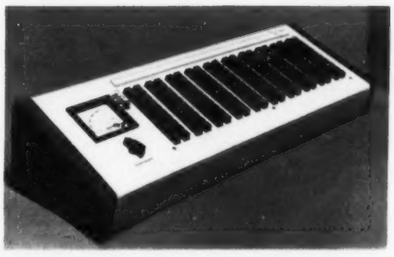
● **Novotechnik KG, Ruit, nr. Stuttgart, Germany,** in conjunction with the Deutsche Studiengemeinschaft Hubschrauber, has developed the U 101 equipment to detect centre of gravity travel in aircraft and surface vehicles. Torque, angular velocity and accelerations are measured either via direct-recording systems inside the recorder, or via accelerometers with electrical output for connection to electrical measuring systems.



● **Zuse KG, Bad Hersfeld, Germany,** showed the Zuse Z 23 and Z 31 programme-controlled electronic computer systems. Both equipments consist of a fully-transistorized computer as basic unit. An extensive collection of accessories enables the equipment to be adapted to the requirements of the user. Price is within reach of medium-size companies. The accompanying picture shows part of the Zuse Z 70 manufacturing control and accounting centre.



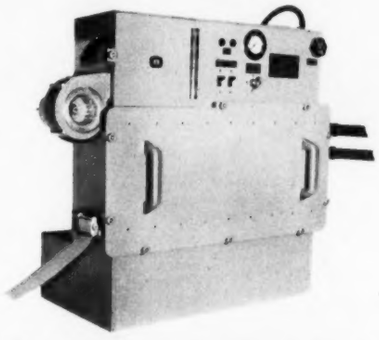
● **Varian Associates, Porto Alto, Calif.:** Exhibits included the new V-7405 Klystron power supply set, which meets the highest standards.



● **Güttinger, Niederteufen, Switzerland,** brought to Düsseldorf not only the AR2 and AR3 analogue computers (the latter in building block form) but also the *Statistic* processing equipment with the aid of which statistical data can be handled rapidly and simply. Lengthy computation to determine mean values and dispersion is eliminated by the use of a new analogue computing principle developed by Güttinger.

● **Allen B. Du Mont Laboratories Inc., Clifton, New Jersey,** showed a visual analogue-digital converter (Type 425) of an entirely new kind. By combining oscillograph and digital techniques, a wide range of applications is opened to the oscillograph. With the aid of two light spots, which can be adjusted by milled thumb switches, data can be indicated in digital form and read off for further processing.

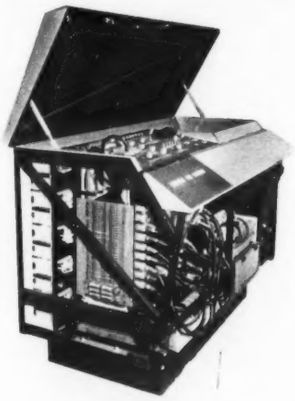
● **Bodenseewerk Perkin-Elmer & Co. GmbH, Ueberlingen, Germany,** showed—among other items—the 137 UV automatically-recording split-beam spectrophotometer, which is probably the only equipment of its kind working on the optical null principle, with high stability and low consumption. Its low price entitles it to be described as revolutionary.

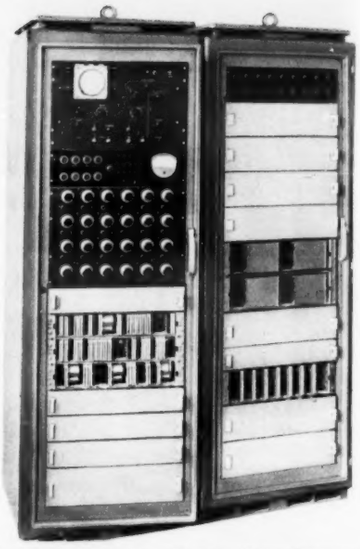


● **Kelvin Hughes Ltd., Wembley, England,** is marketing a new film developing machine, the RP.1, in which the exposed 16-mm, 35-mm or 70-mm film is automatically and continuously developed (as opposed to the step-by-step treatment of the film in the well-known RP.3 machine). Film can be treated up to projection stage in 30 or 60 seconds, depending on model.

● **Société de Fabrication d'Instruments de Mesure (SFIM), Chassy, France,** exhibited an equipment for the testing of precision ball bearings of small dimensions, such as are used, for example, in navigation instruments.

● **Compagnie Européenne d'Automatisme Electronique, Paris,** organized demonstrations of the RW-300 industrial digital computer shown on the company's stand. Several orders have already been received for this equipment from European countries. In the United States the FAA, for example, also uses a computer of this type to simulate and analyze procedures for air traffic control.

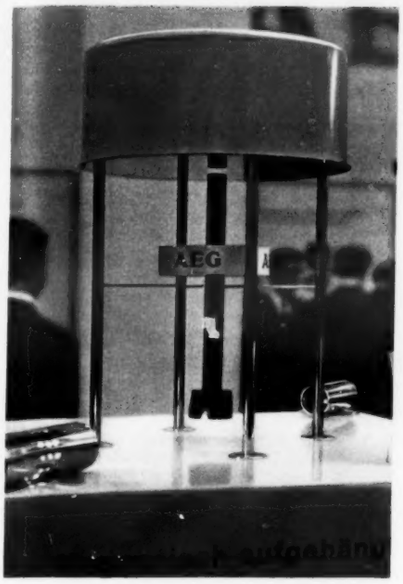




● **Brown, Boveri & Cie., AG., Mannheim, Germany,** showed an electronic simulator for high-temperature reactors, designed for training purposes. In the picture, left, the computer portion with control panel; right, the power supply portion.

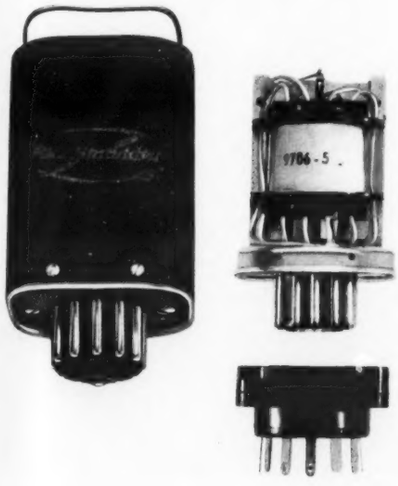
● **Fabbrica Apparecchi Scientifici, Milan,** introduced a new electronic two-position controller in a standard 144 × 144 mm casing.

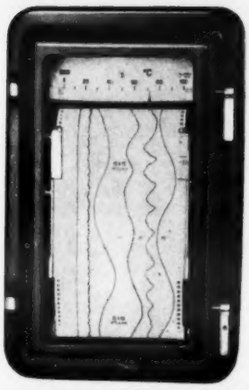
● **Siemens & Halske AG, Berlin,** displayed the new *Oscillomat* cathode ray oscillograph for the investigation of oscillation processes in high tension and telecommunications techniques. Seven measuring processes are displayed simultaneously on seven cathode ray tubes and recorded on a light-sensitive strip. With the aid of a high-speed automatic developer, the strip can be read 10 seconds after the measurement process has begun.



● **Allgemeine Elektricitäts-Gesellschaft (AEG), Berlin,** demonstrated the efficiency of the *Geacont* controller with a magnetically suspended cylinder which is maintained in a floating state by appropriate regulation of the magnetic field. Rapid response, small dimensions, shock-proof construction and reliability are the chief characteristics of the *Geacont*.

● **Standard Elektrik Lorenz, Stuttgart, Germany,** showed the new "S" poled relay, with contacts fitted inside a hermetically sealed gas-filled glass tube. No re-adjustment of contact spacing is required, and the device can be utilized under the most difficult conditions.



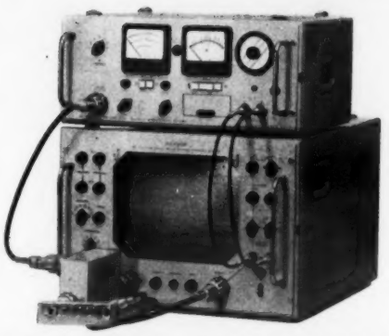


● **Strumenti Industriali e Scientifici (SIS), Milan,** showed the SPE spot recorder for the automatic and simultaneous recording of 1, 3 or 6 parameters in different colours on the same strip.

● **Racal Engineering Ltd., Bracknell, England,** displayed the RA.81 plan position receiver, a successful combination of the RA.17 receiver with the RA.66 plan position indicator. All emissions within the HF spectrum can be displayed on the screen with great precision. The equipment is therefore especially suitable for research and monitoring purposes.

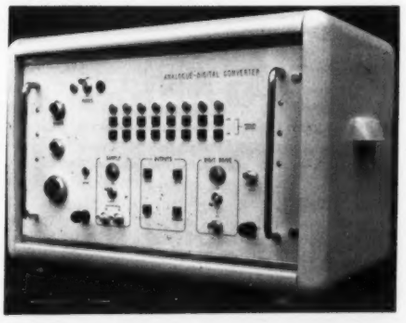
● **Telefunken GmbH, Berlin,** displayed for the first time the new DG13-38 oscilloscope. This is suitable for wideband oscillographs, particularly for use in nucleonics and radar.

● **Marconi Instruments Ltd., St. Albans, England,** showed a range of interesting electronic measuring instruments. New items included the TF 1342 low-capacitance bridge, the TF 978 VHF admittance bridge and the TF 868B universal bridge. The accompanying picture shows the TF 1245 circuit magnification meter, which undertakes direct measurements of Q-factors in the frequency band from 1 kc/s to 300 Mc/s, and which aroused considerable interest.



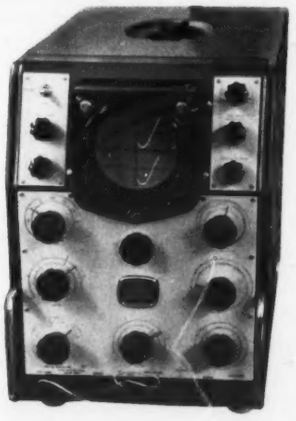
● **Rohde & Schwarz, Munich,** showed the new *Selektomat* (shown in the picture in combination with the already known *Polyskop*), which, through automatic tuning and electronic frequency control, greatly facilitates the matching and measuring of frequency responses.

● **Ampex International S.A., Fribourg, Switzerland,** showed a selection of high-performance magnetic tape recorders, including the Model AR-200, an analogue recorder for use in aircraft and surface vehicles. The electronic portion of the equipment is fully transistorized. It is suitable for direct and digital recording on 14 analogue or 16 digital tracks.

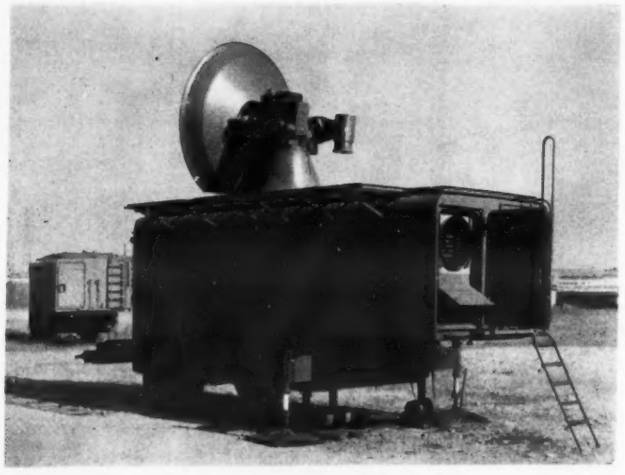


● **Armstrong Whitworth Equipment, Hucclecote, England,** exhibited an 8-bit analogue-digital converter capable of performing up to 55,000 conversions per second. Results can be tapped during conversion as a series of pulses or subsequently read off directly from a lamp display.

● **Cossor Instruments Ltd., London,** exhibited a series of electronic test equipments and oscillators, including the 1035 Mk. IIA split-beam oscillograph for research and industrial purposes.

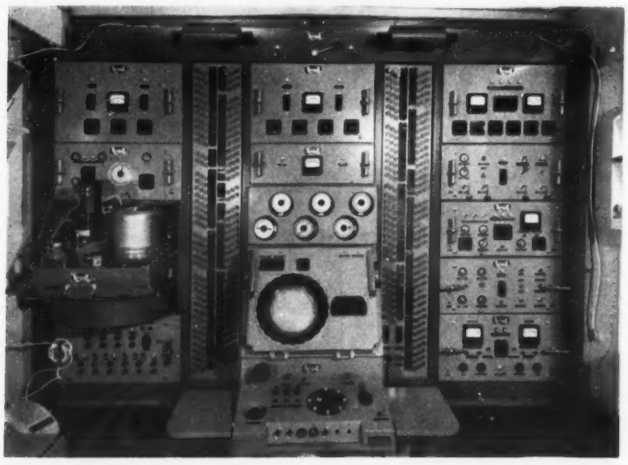


What's New in Electronics?



● **Compagnie Française Thomson Houston, Paris,** is the designer and constructor of the TH.D.1230 Automatic Tracking Radar. The equipment is mobile, and the illustration shows the radar trailer with the antenna erected for operation. For transit, the complete aerial unit is retracted into the trailer body. The second illustration shows the operator's console inside the trailer with the PPI and Type A display scopes. The three pairs of dials mounted immediately above the displays, indicate elevation, azimuth and range data in coarse and fine scales.

This equipment played an important part in the control of the *Mirage IV* on September 19th, 1960 when René Bigand broke the world record for the 1,000 kilometre closed circuit. A course was chosen for the record attempt, consisting of a circle 502 km (310 miles) in circumference and some 80 km (50 miles) in radius with Paris at its centre. The radar was positioned at Brétigny, south of Paris, and nine check points on the course were registered on the plotting display. For the record flight the aircraft had to make two circuits of the course at an altitude between 38,000 and 48,000 feet and to complete each circuit at a greater altitude than at the commencement. The flight path of the aircraft had to be outside the circle of nine check points but at the same time remain as close to them as possible to avoid enlarging the circumference of the circle. As the flight was carried out in a continuous gentle turn, the flight controller maintained the aircraft on the desired circuit by directing the pilot to increase or reduce the angle of bank to tighten or slacken the turn as required.



The record was successfully achieved with a speed of 1,820 km/h (1,160 m.p.h.) which is indicative of the capabilities of the radar to lock-on and track a target moving at high speed.

The radar operates between 2,900—3,100 Mc/s (S band) and has a peak power of 800 kW. The range is 300 km (180 miles), and it is capable of automatically tracking targets situated between 0.5 and 270 km (0.5 to 160 miles). A special version is available for tropic conditions.

● **Ferranti Ltd., Edinburgh, Scotland,** has introduced a new Airstream Direction Detector, developed from a system produced by *Specialties Inc.*, of America. The components illustrated here consists of: 1) Probe unit and sensing element. 2) Servo generator. 3) Panel display. 4) Visual indicator lightbox. 5) Controller.

The Airstream Direction Detector will sense the direction of the local airflow to an accuracy of better than 0.1 degrees, at speeds over 90 knots, and gives a continuous reading with no flutter or overshoot from 60 knots to Mach 4.5.

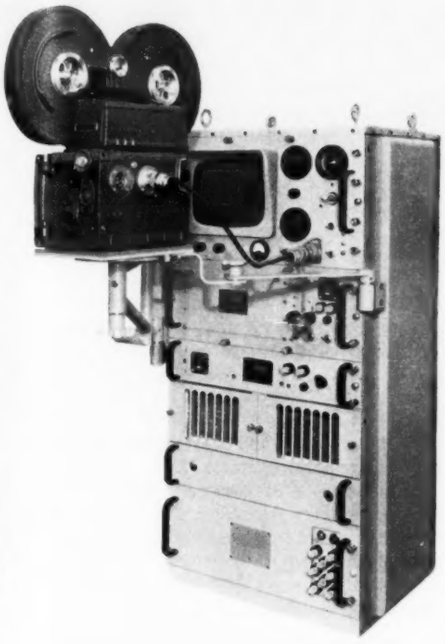
When used to sense angle of attack, the system may be used as the primary aid in preference to the airspeed indicator in all phases of flight. During take-off, climb away, approach and landing, the optimum angle of attack for the particular aircraft configuration may be set up and maintained.

Basically the system consists of a sensing element mounted on the airframe, a panel indicator and an approach aid. A stainless steel probe mounted on the side of the aircraft fuselage projects horizontally into the airstream. Two perforated slots in the probe transmit air pressure through separate passages into opposite sides of a paddle chamber. The paddle is connected mechanically to the other end of the probe within the housing. When the airflow direction is steady, the pressure differential on either side of the paddle will be zero, but if the angle of attack changes, the two slots are presented unequally to the airflow, and the paddle and probe will rotate to maintain a differential pressure of zero. As the probe rotates, it positions two output potentiometers which provide the electrical signals for remote indication.

Output from one potentiometer is transmitted to the panel indicator, which is suitable for all phases of flight including catapult take-off, climb away, cruise control, approach and landing. The second potentiometer feeds the approach aid which supplies the pilot with a visual and audio indication of the optimum angle of attack on the approach.

When installed on the underside of the airframe, the detector will give an output proportional to the angle of sideslip. A sideslip indicator will enable the pilot to trim the aircraft for maximum performance, or the detector output may be fed to an auto-pilot for correcting lateral instability.

The Airstream Direction Detector System has been adopted by the Royal Navy for use on *Scimitars*, *Sea Vixens* and Blackburn NA.39 *Buccaneer* aircraft.



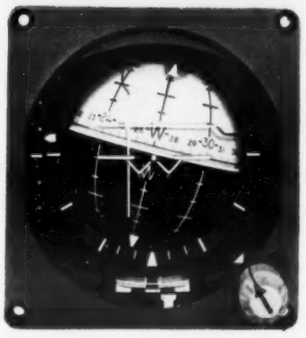
● **The Bendix Corporation, Freize Instrument Division, Towson, Md.,** has issued a report on the AN/BXQ-1 (V) television equipment developed for the Bureau of Ships and installed on the nuclear-powered submarine USS *Seadragon*. Television equipment was first used on the SSN571 *Nautilus* to view overhead ice during the voyage under the polar icecap, and initial results were sufficiently encouraging to prompt the development of higher sensitivity equipment. The experience gained on the submarines *Nautilus* and *Skate*, suggested many improvements and design considerations which are associated with submarine service, and these have been incorporated in the AN/BXQ-1 (V) equipment.

Deep ocean water and arctic water are considered to be relatively clear although there is a high attenuation of light transmission. The sensitivity of the camera in this equipment is sufficient to give pictures of pressure ridges in the ice at a range of 400 feet, with the illumination from half-moon light filtered through 4 to 5 feet of ice coverage. This sensitivity makes television techniques suitable for searching for thin ice, estimating the ship's drift prior to surfacing, and estimating ice thickness.

The television camera is mounted in a fairing on the forward deck. A prismatic optical system gives a 30° × 22° field of view which can be directed through 60° in azimuth and 225° in elevation. Camera training is controlled, and the direction of view indicated, by the control-indicator located at the periscope station. A display monitor is installed at the same point. The electronic equipment (illustrated here) is completely contained in one cabinet and is fitted with full provisions for remote control and adjustment.

The top unit of the cabinet contains the remote controls and indicators for positioning and focusing the deck camera. It also contains an 8 inch monitor which can be used for system adjustment or for photography in conjunction with the 16 mm film camera. This camera is mounted on a detachable frame assembly which can be folded to give aisle clearance in an emergency. In normal operation an operator is not required at the equipment cabinet, since all critical circuits have been provided with automatic controls. In conditions of poor illumination, when maximum sensitivity is required, an operator is needed to adjust one control.

After *Seadragon* had completed her east-west transit of the Arctic Ocean, it was reported that the system had proved so sensitive that it was capable of detecting the phosphorescent light of marine life.



● **Lear, Inc., Santa Monica, Calif.,** is modifying the AN/AJB-3 all-attitude indicating and wings-level bombing system for the McDonnell F4H-1 all-weather fighter aircraft. The attitude indicator now in the aircraft will be replaced by the Lear flight director/attitude indicator illustrated here. The instrument provides information on steering, turn rate, attitude and azimuth on a single face and retains its accuracy in presenting attitude and heading information even under conditions of vertical or near-vertical flight.

The F4H-1 pilot receives steering information from the horizontal and vertical cross-pointers on the indicator. During the bombing mode, "g" indication is displayed on the horizontal pointer. In normal flight this same pointer can be used to display glide slope signals or altitude information. In the bombing manoeuvre the vertical pointer acts as a command for controlling wings-level flight, while in normal flight the pointer provides commands to intercept localizer or omnirange signals, steering commands for correct heading, or any directional command.

A turn rate display is at the bottom of the indicator, replacing a separate instrument, while a tube and ball provides continuous slip or skid information. This instrumentation has been installed in the North American A3J, the CF-104 and the North American X-15.

● **Hughes Aircraft Company, Culver City, Calif.,** is at present conducting flight tests of the TARAN (Tactical Attack Radar and Navigator) system which has been developed by the company. The equipment will enable a fighter-bomber to carry out a low-level mission in adverse weather conditions, and to avoid detection by flying below the enemy radar screen. The three basic capabilities of TARAN are navigation, air-to-ground attack and air-to-air attack.

Automatic navigation is accomplished by an inertial navigator which computes aircraft position and heading. A moving map display, which is prepared on photographic slides from standard aeronautical charts, is projected onto a ground-glass screen so that the map always shows the area over which the aircraft is flying.

The symbol on the centre of the screen (see illustration) represents the aircraft and rotates to conform to the direction of flight. The map of the area moves beneath the symbol in the proper direction to indicate the aircraft's travel.

The radar of the system operates at high microwave frequencies and is claimed to have several times the resolution of current radars. When operated in the ground mapping mode, it is possible to identify roads, bridges and even ditches on the radar scope. The system can also be operated in a terrain avoidance mode. In this mode the radar will respond only to the echoes from objects which are above a certain altitude, and only objects which are a potential danger to the aircraft will appear on the display.

The TARAN system is designed to deliver a variety of weapons in all weathers and by day and night. For air-to-ground operations, bombs can be delivered against ground targets using simple gravity drop, dive, toss, loft or over-the-shoulder techniques. For attacking airborne targets, the TARAN system has provision for radar search-and-track operation and for launching both radar-guided and infrared-seeking air-to-air missiles.

● **Collins Radio Company, Cedar Rapids, Iowa,** has announced the development of a lightweight airborne weather radar system weighing less than 50 pounds. The WP-103 equipment covers the sky area up to 150 nautical miles ahead of the aircraft with a stabilized antenna which makes a 120 degree sweep at 60 scans per minute. The pulse-modulated radar operates in the X-band frequency, and the power requirement of the WP-103 is only 320 watts a.c. Extensive use of transistorized and printed circuitry has made the low weight and power economy possible. For use in daylight without the use of a scope hood, a bright tube indicator can be supplied as optional equipment.

Video Map Equipment

By S. Severini and T. Lazzari, Fabbrica Italiana Apparecchi Radio, Milan

The authors, both born in 1927 and both graduates of the Milan Institute of Technology, have for many years specialized in the fields of telecommunications and pulse techniques. Here they report on a method of electronically introducing maps and drawings into radar images.

Editors

The surveillance radar operator's task is greatly lightened if certain additional information is presented on the radar screen at the same time as the echo of the aircraft under control; this information can take the form of prescribed flight paths, prohibited zones, reporting points, obstructions etc. Taken together, these additional data form a simplified map of the terrain surrounding the airport. The operator of the surveillance or precision approach radar can direct the pilot when he has ascertained that the aircraft echo is passing between the two lines representing the prescribed flight path.

It would, of course, be possible to obtain the additional indications simply by chalking the required marks directly on the PPI or by drawing a schematic map of the area on transparent material and sticking it to the radar screen. It would also be possible to project the map onto the screen by means of mirrors. But such methods have certain disadvantages.

With an optical system, in which slight distortions of the radar image can never be avoided, it is impossible to accurately superimpose the map on the latter, i. e., the outlines on the map do not correspond with the electronic radar picture. Moreover, parallax errors arise owing to the thickness of the screen, for the luminous surface and the map are on opposite sides of the glass.

If a map is glued or drawn on the PPI, its outlines are not easily recognizable against the dark background of the screen. The map would have to be drawn with broad outlines to lessen the strain on the operator's eyesight. What is more, it is difficult to fit the drawing to the curved surface of the screen, and there is the risk of the transparent sheet on which the map is drawn becoming distorted with age.

Severino Severini

Tito Lazzari

It is therefore preferable to *scan the map electronically* and to present it on the screen together with the radar image. In other words, the outlines are "viewed" by a photo-electric cell and transformed into a series of electrical pulses. These pulses are added to those which produce the radar echoes, by a process which is described in detail below. The equipment used is thus a simplified television camera, generally known as a video map generator; it offers the following advantages.

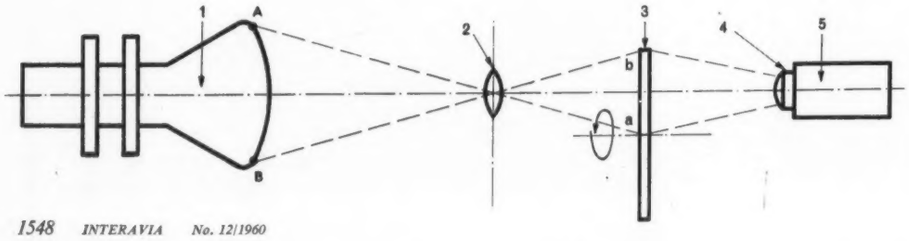
– The electronic reproduction of the map outlines has the same distortions as the radar picture, and the superimposition of the two pictures is therefore accurate.

– There is no parallax error, as map and radar image appear on the same side of the screen.

– The map is presented by luminous lines whose brightness can be regulated as the operator requires, sparing his eyes by giving the best resolution and the most favourable operating conditions.

– Finally, the video map generator can be built with several channels, so that several individual maps can be scanned simultaneously. The radar operator can select the desired channel and the appropriate map merely by actuating a switch, e. g., when he changes the range of the radar or off-centres the picture.

Fig. 1: The spot generated by the electronic beam (1) scans back and forth in a straight line between A and B and is projected by the lens (2) over the radius of a transparency (3). The latter rotates about its axis, so that the entire picture is presented. The light beam is modulated by the transparency and passes through the condenser (4) to the photo-electric cell (5).



Method of operation

The video map generator can take a variety of forms. First, a brief description of the method of operation of the system normally used: The map is "read" from a transparency by the flying spot scanning method (cf. *fig.1*). The simplified map, on which the flight paths and other information necessary to air traffic control are drawn, is the photographic negative of a drawing, where the details to be reproduced appear transparent on a dark glass plate *(fig. 2)*.

The transparency is mounted in front of a cathode ray tube similar to that of a television set. The electromagnetically focused beam falls on the fluorescent layer on the face of the tube and causes the point which it touches to glow. This point source of light is projected by the lens onto the transparency. The bright spot is then oscillated so that it scans the entire transparency, and touches all the points on its surface in succession. This action, which is repeated periodically, can be produced in a variety of ways, two of which are discussed below.

1 – The spot moves along the radius of the circular tube face from the centre to the edge, where it is extinguished, to reappear again in the centre. From thence it resumes its radial movement, but along another radius at an angle of a few minutes of arc from the first. This movement of the electronic beam is effected by a magnetic field produced by rotating coils.

2 – The spot moves across the entire diameter of the screen. When it arrives at the edge, it disappears, reappearing in its original position to continue its movement across the same diameter. The path of the spot appears as a straight line. The transparency rotates in front of the cathode ray tube about an axis perpendicular to the centre of the tube face. The lens projects the bright line from the tube onto the transparency, the length of the projected line being equal to the radius of the transparency *(cf. fig. 1)*. By this movement the entire surface is scanned by the bright spot.

Whatever the method of scanning, the light produced by the spot can pass through the glass plate only at points where it is trans-

parent. An optical condenser directs the light which has passed through onto the sensitive cathode of a photo-electric cell. The map is thus transformed into a series of light pulses, a process which is repeated periodically each time the transparency is scanned. These pulses, which are of equal intensity but different length, trigger proportional electrical pulses in the photo-electric cell. The radar antenna supplies electrical pulses for the radar echoes; these are added to the pulses coming from the photo-electric cell, thus producing the desired superimposition of map on radar image. The combined signal thus obtained is converted to a fluorescent image on the radar PPI tube. To achieve this, the combined signal causes variations in the intensity of an electronic beam, as in a television set; this beam moves over the tube synchronously with the electronic beam which scans the transparency. The point hit by the electronic beam glows on the screen, the afterglow producing a composite picture containing the radar image and the schematic map. The movements of the antenna, the spot passing over the transparency and the spot on the radar screen, must be accurately synchronized.

The FIAR video map generator

For a better understanding of the foregoing, the construction and method of operation of a video map generator of the flying spot scanning type are described below. The equipment was developed by Fabbrica Italiana Apparecchi Radio (FIAR) in Milan and can be used with fixed and mobile radar installations at civil airports, and also for military purposes. It is at present being produced in quantity. The system has two channels and therefore offers the possibility of reproducing two different transparencies at once. It contains the following units *(fig. 3)*.

1 - Optical system

This system projects the spot produced by the moving electronic beam onto the surface of the transparency and concentrates the light which passes through onto the photo-electric cell. The transparency is scanned by combining the rectilinear movement of the spot along the diameter of the cathode ray tube with the rotary movement of the transparency about its axis, i. e., the second of the methods described above has been chosen. The optical system consists of two lenses (one for each channel), which focus the beams from the cathode ray tube onto each transparency. Each lens has controls for accurate centring and focusing.

An adjustable optical condenser between lens and photo-electric cell concentrates the light on the central portion of the latter's cathode. This is necessary because the surface of the cathode is very small, and light dissipation must be avoided.

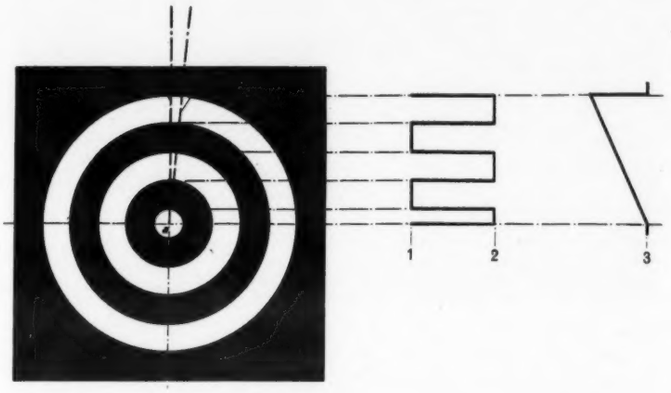


Fig. 2: Example of a simple transparency and the corresponding electrical signals at the output of the photo-electric cell. (1) and (2) are the voltage differences proportional to the light intensity differences in the transparency; (3) is the time base.

2 - Photo-multiplier

This considerably increases the electronic current emitted by the cathode of the photo-electric cell (by about 12 dB), thus obtaining maximum sensitivity of the optical system by simple means. The signal emitted by the photo-multiplier passes through an image pre-amplifier, whose final stage takes the form of a cathode follower which matches the impedance of the pre-amplifier to that of the coaxial cable connecting the pre-amplifier with the video amplifier.

3 - Video amplifier

This amplifies and limits the signals from the pre-amplifier and passes them through three independently controllable outputs for each channel.

The video amplifier provides distortion-free amplifications of all pulses whose duration is between 1 and 3,000 microseconds, with rise and fall times equal to or less than 0.2 microseconds. The output signals are positive, and the amplitude can be adjusted as required on a 100 ohm impedance.

4 - Time base generator

This unit has the following tasks:

- To generate the saw-tooth voltage to deflect the beam of the cathode ray tube at a frequency which can be adjusted to match that of the radar PRF;
- to scan the electronic beam during the saw-tooth voltage rise time;
- to cut off the extra high tension (22 kV) to the cathode ray tube if the synchronizing pulses are inoperative, i. e., when no deflection is taking place.

5 - Servo-mechanism

This rotates the transparencies synchronously with the radar antenna. It comprises two transparency mounts, consisting of:

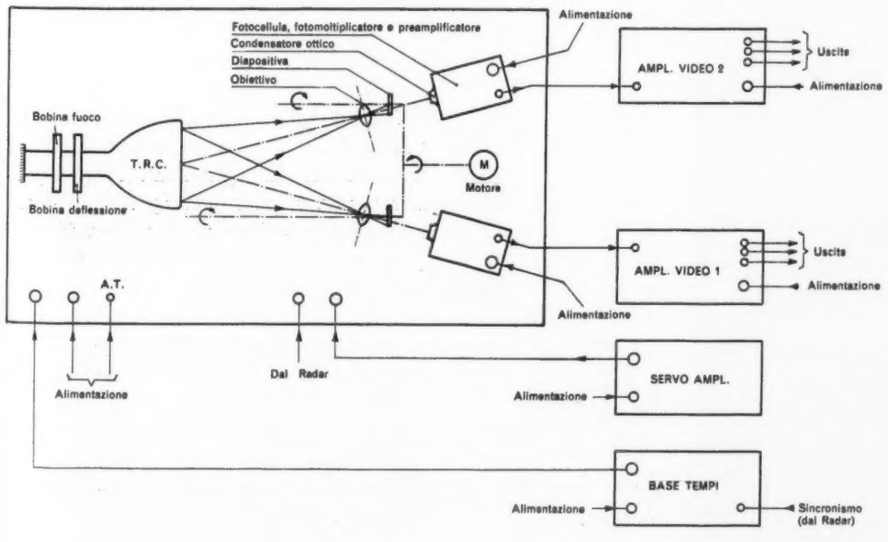
- turntable with transparency frame;
- gears with cog-wheels for the different reduction ratios, and motor;
- synchro transformer in the ratio 1:1 (coarse);
- synchro transformer in the ratio 1:n (fine) with n = 16, 30 or 36.

6 - Power unit

This supplies:

- anode voltages for the valves; these voltages are stabilized so that they remain unaffected by changes in the mains voltage and power consumption;
- stabilized negative voltages: 700 V for the photo-electric cells in the video amplifier

Fig. 3: Block diagram of the two-channel video map equipment developed by FIAR of Milan.



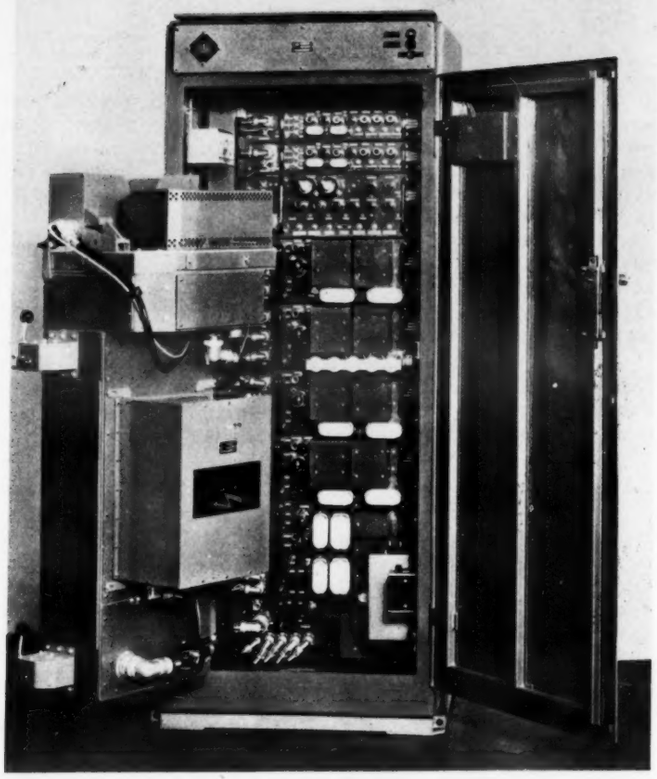


Fig. 4: Front view of the open cabinet. The swivelling frame in front contains the optical and electrical part of the equipment and the cathode ray tube.

and 300 V for the grid voltages on the various units;
- 6.3 V for the heater circuits;
- 22 kV d.c. for the anode of the cathode ray tube.

Performance of the FIAR Video Map Generator

The equipment can be operated by untrained personnel. It suffices to set the transparencies in the mounts, and the required images will at once appear on the radar screen. Two interchangeable video channels enable two transparencies to be scanned at once, making it possible to present two different maps or the same map in two different scales.

The following modes of operation are possible:

1 – The simultaneous feeding of three displays, with the possibility of presenting either of the two maps on each display;

2 – The simultaneous feeding of six displays, with the same map presented on all six (for this two identical tranparencies are required);

3 – The feeding of six displays, with one map on three screens and another on the other three.

The equipment has been built to the British K 114/E standards and can operate at temperatures between −40 °C and + 55 °C and a relative humidity of up to 95 percent. It can work in conjunction with *plan position radars* having the following characteristics:

antenna rotation speed	up to 15 r.p.m.
azimuth transmission	by coarse and fine synchro transmitter
range	50 to 240 nautical miles
pulse recurrence frequency	100 to 1,600 p.p.s.
positive pulse for synchronizing time base	amplitude of 4 to 100 V duration from 0.1 to 10 microseconds.

It is possible to reproduce a raster of black and white lines, in which the widths of the lines can be less than 1/700 of the diameter of the scanned zone. The non-linear distortion is less than 1 percent. The angular error in a synchro transformer with a ratio of 1:30 is less than 4 minutes.

Electrical and mechanical qualities

The FIAR equipment's power consumption is 800 VA; the signal voltage at the video output is adjustable between 0.5 and 3.5V; the signal polarity at the video output is positive. All the components meet the JAN or MIL specifications applying to this type of equipment, and the cathode ray tubes are those quoted in the NATO or MIL-STD-200c preference lists.

The video map equipment is housed in a metal cabinet 59 inches high, 26.8 inches deep and 29.5 inches wide, and weighs 660 lb. The cabinet is fitted with shock absorbers for transport and mobile installation. Here the equipment can withstand accelerations of the order of 10 g.

The cabinet contains a 19 inch standard rack, on which the following units are mounted: servo amplifier, video amplifier, time base, servo amplifier power unit, time base power unit, high tension power unit, video power unit, power unit for negative bias voltages.

The rack can be swung out of the cabinet on double hinges, so that the backs of the units are accessible. The optical and electrical part is mounted on a swivelling frame, whose hinges are at the front of the cabinet *(fig. 4)*. This frame carries the cathode ray tube with its 22 kV power supply, the optical system and the mechanical system, comprising the transparency mounts *(fig. 5)*, the synchro transformers, the servo motor and the two preamplifiers.

Finally, on the front panel of the cabinet are mounted the main switch, a warning lamp for cathode heating and a warning lamp for the anode voltage. ←→

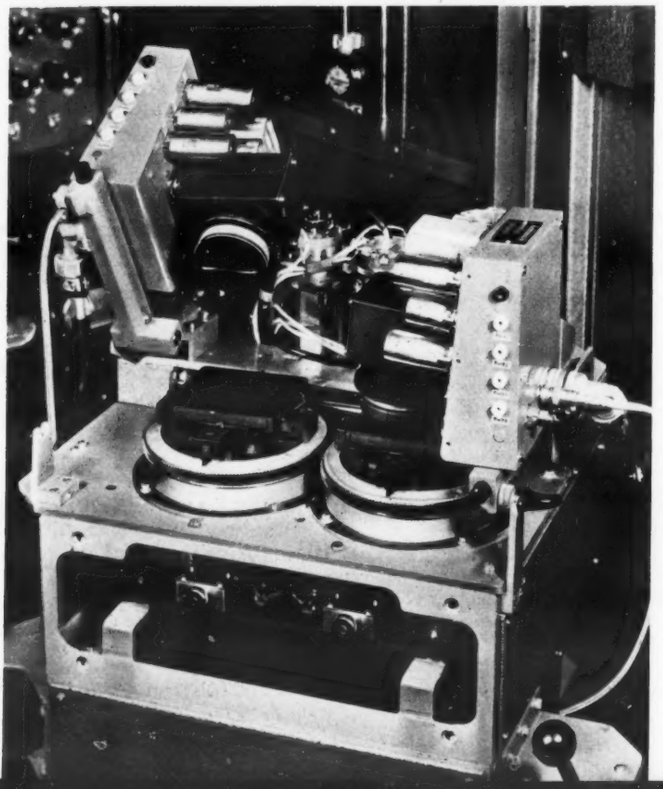


Fig. 5: The optical and electrical part of the equipment with protective covers removed. Both units are clearly visible, each with lens, photo-electric cell, photo-multiplier and pre-amplifier. One of the units is shown erect, the other in the normal operational position. The rotating transparency mounts, and in the background the synchro transformers and the servo-motor, are easily recognizable.

The trend is towards **AIR PARTNERSHIP**

More airlines (and airports) are adopting the Air Partner for Jet-liner starting

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These international airlines all use or have ordered the Atlas Copco Air Partner. Airports are also beginning to provide Air Partners as part of their ground service. Idlewild, Orly, Rome and Dusseldorf are among the first! A mobile starting unit which delivers *continuous power*, the Air Partner can be used on all jet and turbo-prop airliners with air turbine starters. A touch of the controls and it becomes an air-conditioning unit; fix a special mouthpiece to the air hose, and you have a de-icing machine. The Air Partner can be mounted on a trailer or any suitably-sized chassis—Ford, Volvo, Willys, etc.

MINIMUM MAINTENANCE

The Air Partner consists of an Atlas Copco TWIN-AIR rotary screw compressor —a design based on some ten years' testing and operating experience. Supplying a constant flow of warm, oil-free air—an essential condition for efficient starting —this compressor has few moving parts. Wear is thus practically eliminated and maintenance costs cut to a minimum—10,000 hours is the normal period between overhauls for screw compressors of this type. Maintenance on the Air Partner can be carried out by airline personnel anywhere in the world or through the Atlas Copco sales and service organisation established in ninety countries.

WRITE FOR THE BOOKLET

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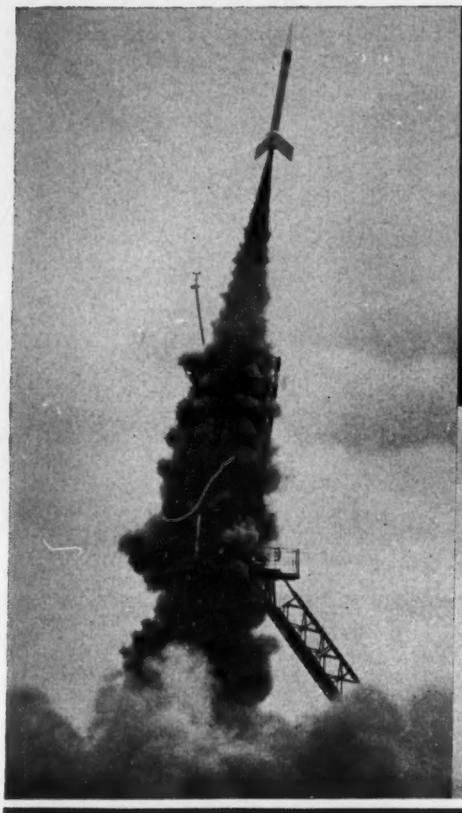
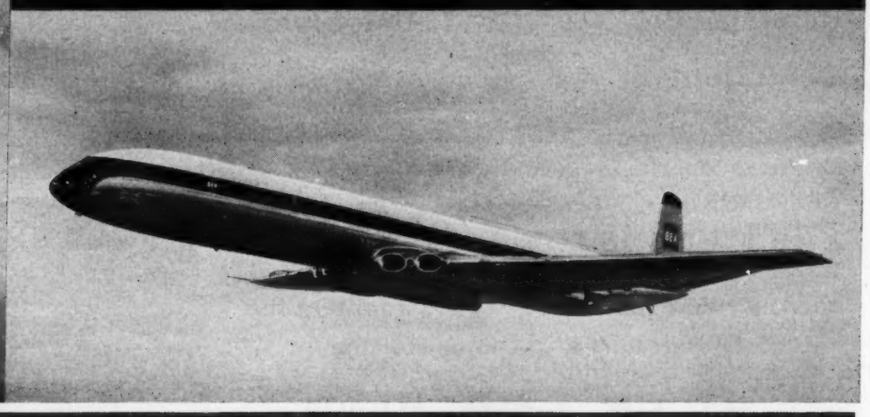


MUCH MORE ENERGY IN THE AIR—AND BEYOND



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Made of chrome molybdenum steel, the vessels are welded by the argon shielded tungsten arc process and heat treated to a minimum ultimate tensile strength of 75 tons per sq in. All vessels are examined several times, both visually and radiographically, to ensure the highest standards of welding. These are only two examples of the many stringent quality controls which are performed during manufacture.

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Bristol Aerojet pressure vessels show a weight saving of at least 5 lb per 500 cu in and as much as 50% when compared with forged vessels.

Bristol Aerojet pressure vessels have been supplied to many manufacturers of aircraft and guided missiles for a variety of applications, which include the following.

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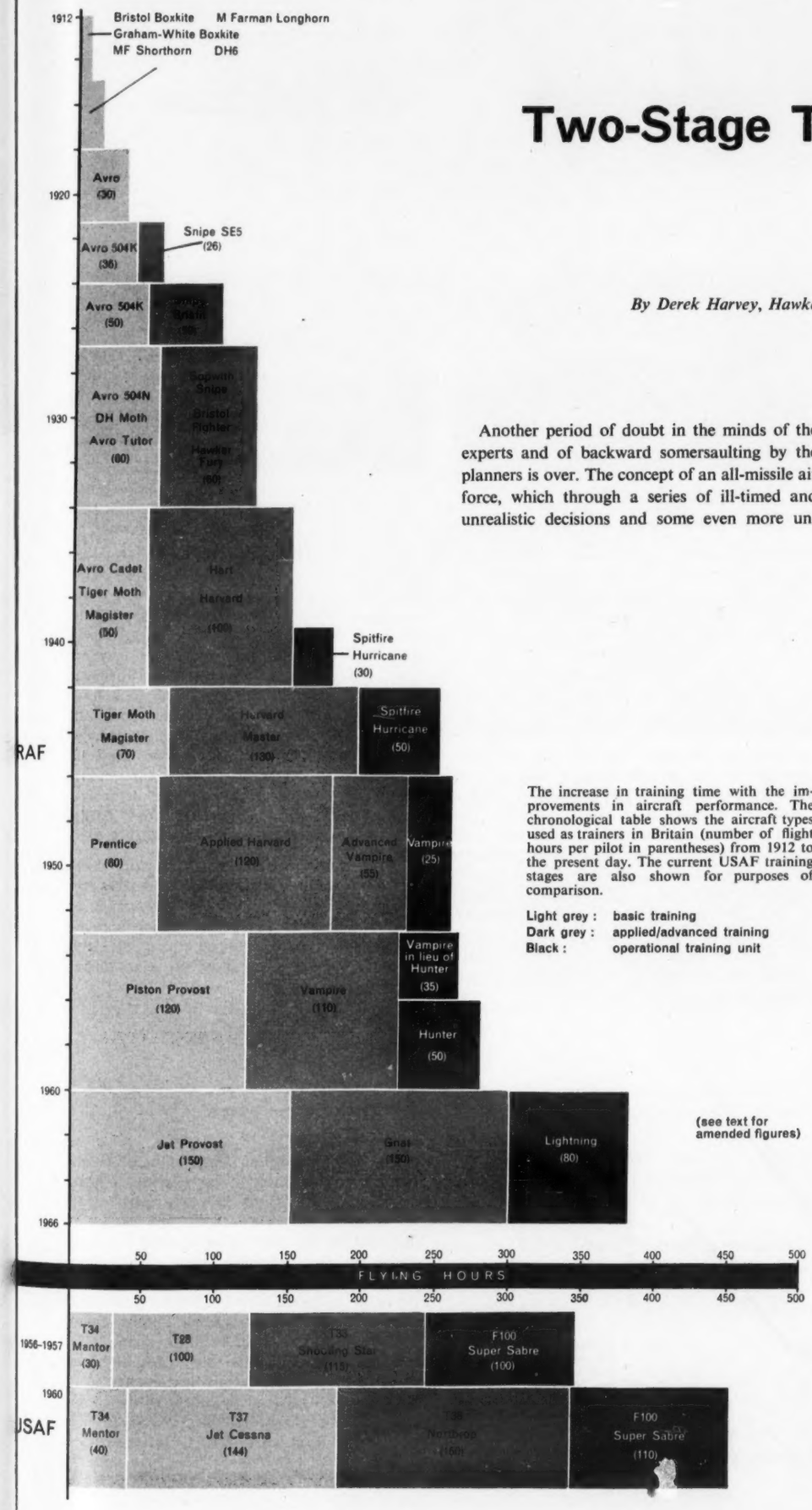
Two-Stage Training, or Three?

By Derek Harvey, Hawker Siddeley Group, London



The increase in training time with the improvements in aircraft performance. The chronological table shows the aircraft types used as trainers in Britain (number of flight hours per pilot in parentheses) from 1912 to the present day. The current USAF training stages are also shown for purposes of comparison.

Light grey : basic training
Dark grey : applied/advanced training
Black : operational training unit

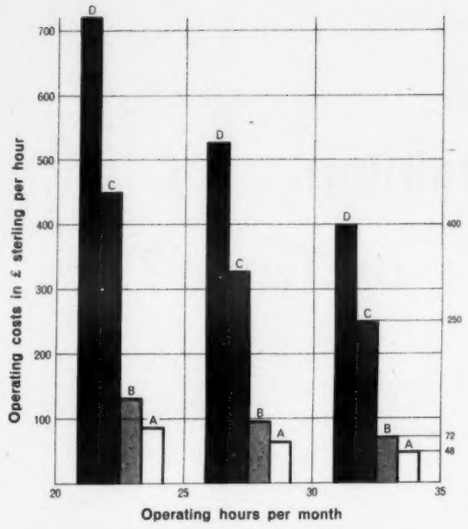
(see text for amended figures)

Another period of doubt in the minds of the experts and of backward somersaulting by the planners is over. The concept of an all-missile air force, which through a series of ill-timed and unrealistic decisions and some even more unfortunate publicity has overshadowed the future of so many young pilots for the past two years, has finally been abandoned—or at least postponed for another decade or two. From a recruiting viewpoint, the future seems clear: a career as an air force pilot probably has more to offer now than at any time in history, even if the grade is becoming increasingly stiff as piloting standards keep pace with technological progress.

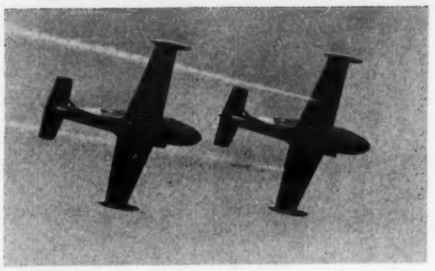
With the introduction of the new generation of supersonic aircraft, training efficiency and standards are being accorded the vital attention they have always deserved, but in the past so seldom received. But as specialized training aircraft replace the converted front-line obsolescents, and training programmes become longer and ever more comprehensive, problems of overall cost begin to assume an importance in the national economy they never had before. Indeed an examination of the financial aspects of pilot training reveals a number of interesting problems.

Whatever slight differences of opinion may exist between the various air forces of the world as to the exact number of flying training hours required by a pupil before he becomes "operational" or can master a particular type of aircraft, most countries now agree that the figure lies somewhere between 400 and 450 hours. And the majority of them appear to subscribe to the view, held by both the RAF and the USAF, that the pupil must complete this number of hours in the first two years of his training, either wholly in a flying training establishment or partly in a training establishment and partly in a squadron.

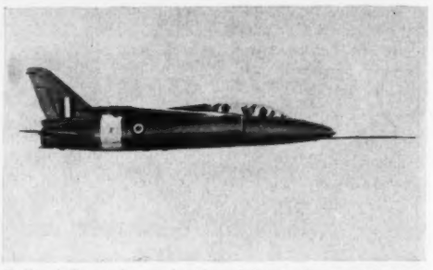
In the RAF, the training programme is to take the form of 160 hours on the *Jet Provost*, followed by 160 hours on the *Gnat Advanced Trainer* and 100 hours on the *Lightning*. The corresponding American interpretation of the same formula is to give pupils 40 hours on the T-34 *Mentor* and 144 hours on the jet Cessna, making a total of 184 hours basic training, as compared with the RAF's 160 hours, followed by 160 hours on the Northrop T-38 and 110 hours on the F-100. A number of other air forces, however, faced with the problems of aircraft procurement to suit their future training requirements, and anxious to standardize on the minimum number of different



The relation between aircraft utilization and operating costs (without depreciation). A. Hunting *Jet Provost* basic trainer; B. Folland *Gnat* advanced trainer; C. typical all-weather supersonic fighter, operating costs with reduced equipment; D. all-weather supersonic fighter, operating costs with complete equipment (integrated weapons system).

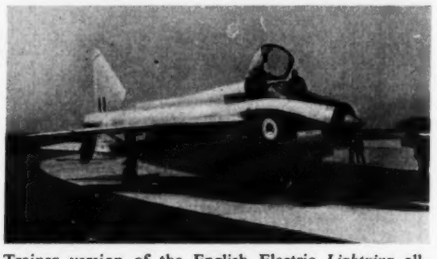


Basic trainer in the £45,000 price range, here the Hunting *Jet Provost*.



Folland *Gnat* advanced trainer (picture shows prototype) for transonic speeds. Price range £130,000.

Typical delta-wing high-performance fighter, here the two-seat GAMD *Mirage IIIB*. Price range £300,000.



Trainer version of the English Electric *Lightning* all-weather fighter. Price range £400,000.

aircraft types, are considering the adoption of a two-stage training sequence as an overall economy. They propose following the American plan of 40 to 50 hours elementary training, or grading, on a simple piston-engined type, followed by 160 hours basic jet experience; but they consider they should then be able to transfer the pupil straight on to the two-seat versions of advanced operational machines—equivalent to the *Lightning*, *Mirage*, or *Draken*—for the remainder of his training, thereby saving the capital cost of an intermediate type.

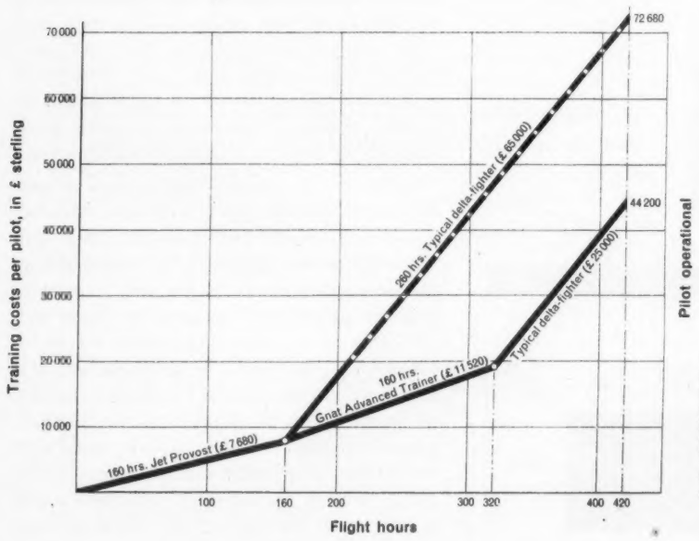
It is generally conceded that advanced trainers such as the *Gnat* or Northrop T-38 have important advantages over a basic type in the final stages of training. They have a higher capability for developing pilot skills, they offer a far longer period of productive training and, most important of all, they bridge the vital gap between the performance and handling of the basic type and that of the operational type by indoctrinating the pupil in the correct environment. The *Gnat*, for example, gives him experience with power controls, swept wing, slab tail, high acceleration potential (3½ g at 45,000 ft), transonic speed, ultra-high rates and angles of climb, the modern operational ceiling of 50,000 ft, and modern instrumentation, radio and ancillary equipment. Uprating the engine of a basic trainer so as to provide increased speed and rate of climb would not appear to serve the same purpose, since its handling in the circuit will still not be representative of the operational type, and with its unswept wings it will not be as prone to inverted spinning, for example. It should never be forgotten that high-performance aircraft react very rapidly to pilot error, especially in the moments of emergency which are more likely to arise with increased speed and complexity. The 210 hours total flying envisaged under the two-stage scheme —barely half the experience considered necessary by the RAF and USAF for a pilot to become operational—would thus appear to be a dangerously low figure.

Apart from their danger, flying accidents are exceedingly costly. In spite of efficient instruction and supervision, they are inevitable during training and occur with greater frequency during the advanced stage than in the basic stage. Recent RAF experience shows, in fact, that they are from 1½ to 2½ times as frequent during advanced training, the actual ratio depending to a large extent on the incidence of technical failures on the particular aircraft. From this it can be deduced that in a two-stage sequence, in which the pilot is brought on to an expensive and complex aeroplane at an early stage of training, the cost of replacements for flying accidents would be appreciably greater than in the three-stage system.

In the matter of capital and operating costs, three-stage training also shows considerable economies. Again taking the *Gnat Trainer* as an example, we have an aircraft costing approximately £130,000 fully equipped, with an operating cost of £72 per hour, based on Air Ministry figures which allow for:—

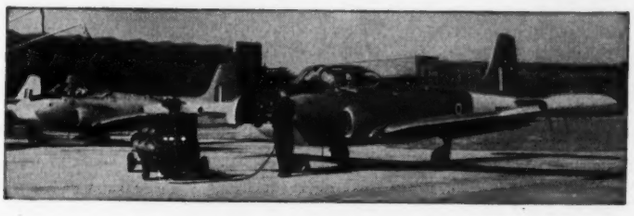
1. 2nd and 3rd line servicing at contractors
2. Fuel and oil
3. Spare parts
4. Replacement of wastage

but not including capital depreciation, or 1st and 2nd line maintenance. By comparison, a front-line supersonic fighter probably costs about £275,000 for the bare aircraft, and cannot be operated for less than £250 to £350 per hour. Based on these estimates, three-stage training costs about £44,000 per pilot over 420 hours flying, as compared with £72,000 for a two-stage programme. Thus for a training output of, say, 150 pilots per year—a representative figure for an air force of medium size—the aggregate saving with the three-stage system would amount to no less than £4.5 million, equivalent to the capital cost of some 16 modern fighter aircraft. It is therefore difficult to see how two-stage training can be justified, either on the grounds of efficiency or economy.



Comparison of typical training costs per pilot for two- and three-stage training. In both cases, 420 hours are flown until the pilot is fully operational. The purchase price of the aircraft is not taken into account.

in service with the Royal Air Force



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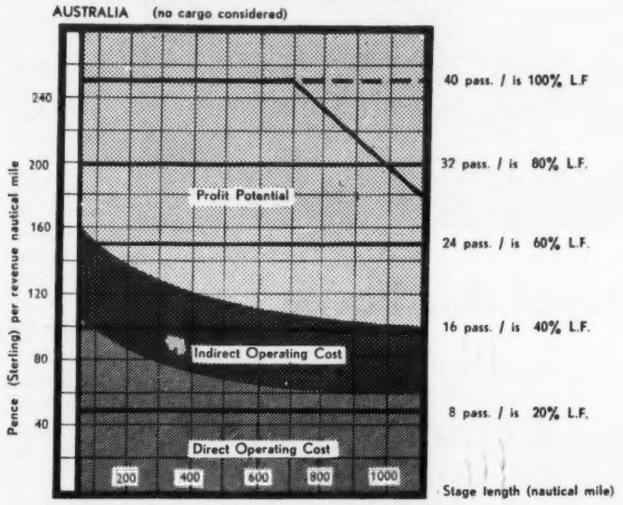
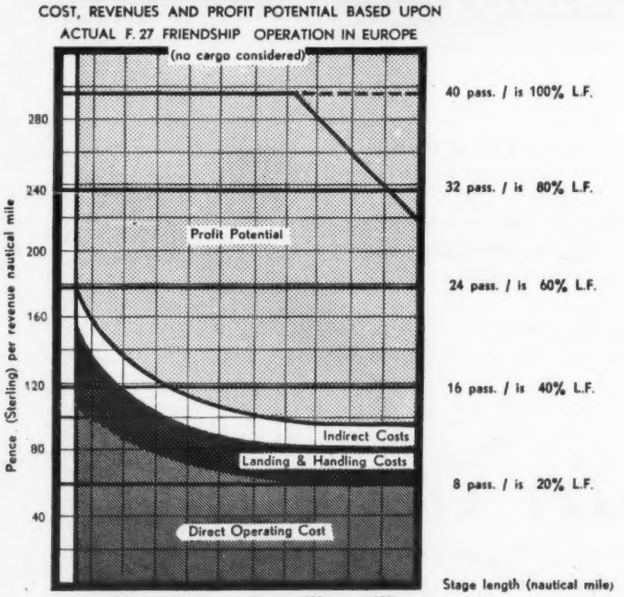


COST, REVENUES AND PROFIT POTENTIAL BASED UPON ACTUAL F. 27 FRIENDSHIP OPERATION IN EUROPE (no cargo considered)



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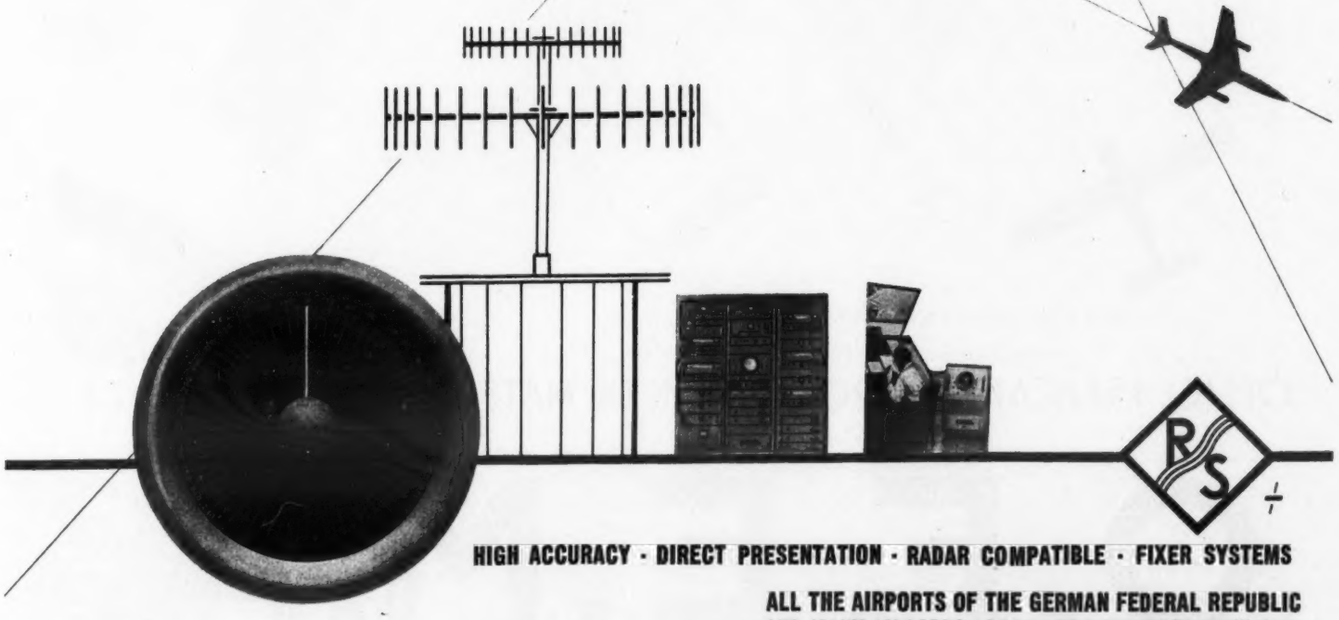

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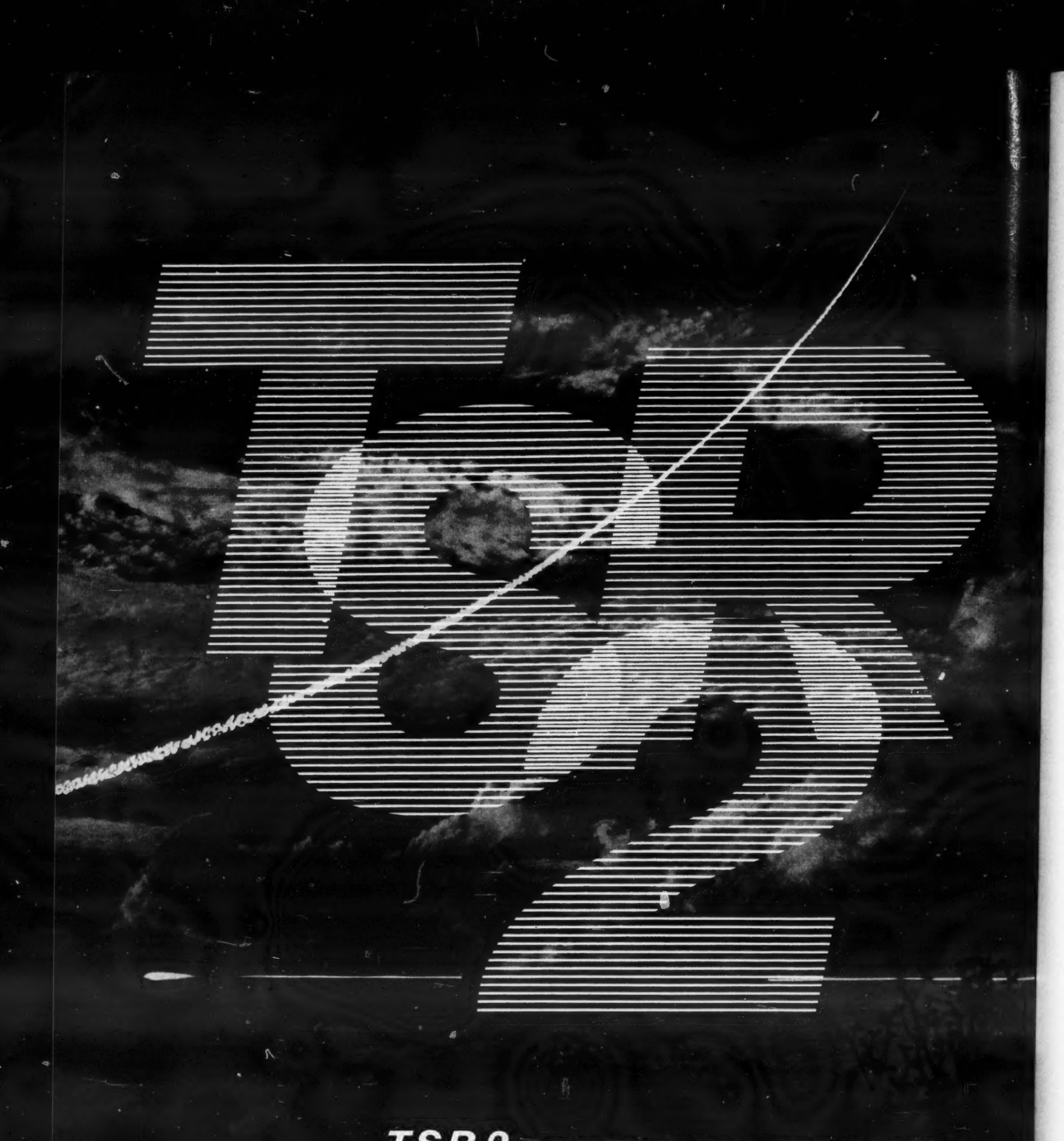

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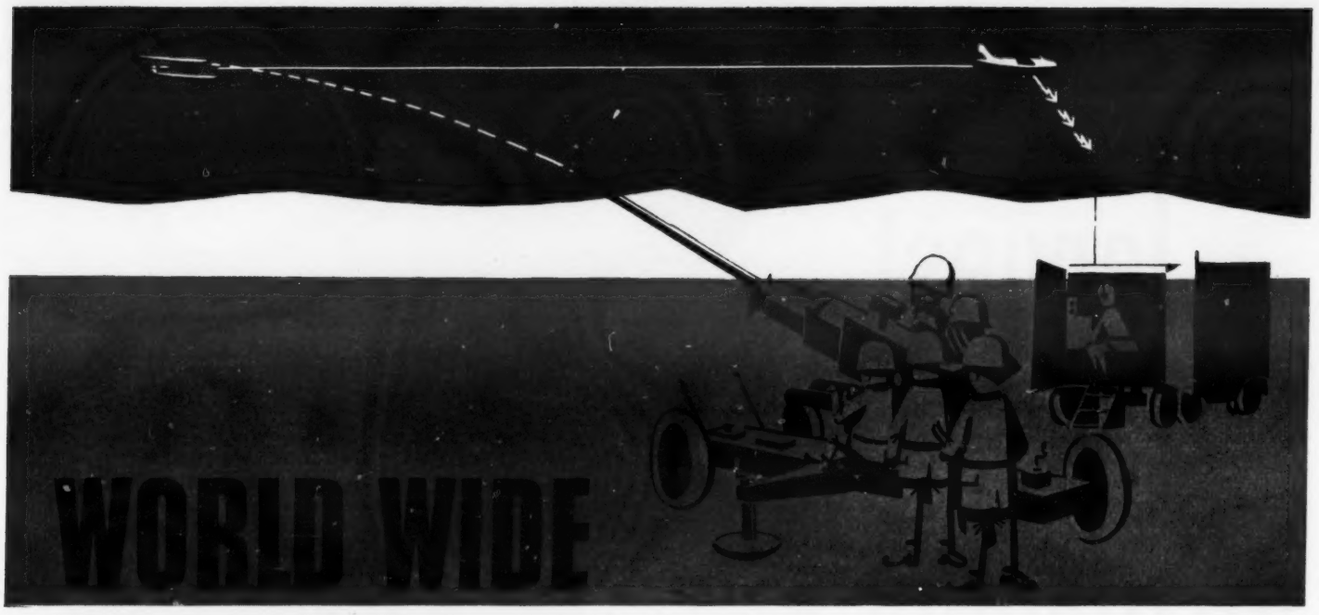

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The English Electric Four-Foot Wind Tunnel

By P. J. Midgley, B.Sc., English Electric Aviation Ltd. (British Aircraft Corporation), Warton, Lancs.

Despite the tremendous progress made in theoretical aerodynamics, research in this field is showing an increasing need of high-performance wind tunnels. As flight speeds grow higher, the demands on test installations become ever more severe. On October 19th, 1960, British Aviation Minister Peter Thorneycroft officially pronounced two new wind tunnels of the English Electric Company ready for operation; these will be used for work on the TSR.2 tactical strike and reconnaissance aircraft, the Blue Water *surface-to-surface guided missile, the projected supersonic airliner and other projects of the British Aircraft Corporation. The following report by a senior engineer of English Electric, who played a leading part in the construction of the tunnels, is therefore highly topical.* Ed.

The English Electric Aviation Company's 4-ft wind tunnel, the fourth tunnel to be built in the Aircraft Division, is the largest intermittent tunnel in Britain. It was therefore inevitable that many design problems with few precedents in wind tunnel engineering had to be faced. Whilst the tunnel has turned out to be similar in its main features to several projected facilities abroad, the achievement of an economically acceptable arrangement without prejudice to the specification was only possible through a design approach from first principles.

It is the purpose of this article to describe our approach to two of the most interesting aspects of the tunnel design—the supersonic nozzle and the tunnel flow control system.

For a proper appreciation of these aspects, however, it is useful first to set out the basic design criteria and the general layout of the facility.

The specification and general configuration

The requirement, in essence, was to cover all foreseeable development testing on high- or low-speed aircraft, with data reliability substantially better than that available from existing facilities, and including:

- coverage of Mach number from zero to a top limit exceeding 3 (to be determined on economic grounds);
- ability to approach flight Reynolds numbers on large-scale component models;
- provision of a range of available Reynolds numbers to permit reasonable extrapolation on complete models, with a maximum of at least 5.10^6;
- suitability for all dynamic testing, including flutter and store jettison testing.

The general layout of the installation which was designed around this specification is shown in *fig. 1*. The facility includes an 18″ tunnel for speeds of up to Mach 6, designed primarily for guided weapon development, and now nearing completion.

For the initial assessment of the size of tunnel required, it was established that typical complete model stress limitations corresponded to a stream dynamic pressure of about 1,600 lb/sq. ft. (7,800 kg/m²).

The corresponding Reynolds number per foot has a minimum at M = 1.4, and indicated a model mean chord of about 8 in. (20 cm) would be required. The working section was chosen at 4 ft square to accommodate such a model without shock-reflection interference at M = 1.4; the resulting frontal area blockage of 0.5 to 0.7% was considered acceptable for transonic testing in a perforated-wall working section.

The top Mach number limit was chosen at 4 to avoid the need for a large air-heating plant; above this Mach number, tunnel static temperature falls to liquefaction point unless the stagnation temperature is raised.

The selected storage pressure of 600 p.s.i. was found both to be the most economic and to satisfy humidity requirements. An acceptable humidity of 3×10^{-4} lb/lb is largely achieved in the compression and cooling processes alone, and a small drying plant has been incorporated so that this may be reduced to 6×10^{-5} if required. The storage volume of 10,000 cu. ft. was established on the basis of an average 30-second running time at moderate Reynolds number (15 seconds being considered adequate for most purposes). The compressor delivery of 6 lb/sec gives an overall data output rate of about 30 data points per hour—i.e., an average of one 15-second run every 50 minutes, with data extraction at 0.6 seconds per data point (24 numbers). This fairly modest output, it was anticipated, could be increased if necessary by a factor of up to 3 or 4 by improved data logging rates. Current trends in instrumentation appear to justify this assessment. Data from force and moment balances, pressure plotting or component load models etc., over a full range of model incidence, are extracted automatically during a run. Processing in the DEUCE digital computer should ensure ample time for assimilation of data between runs. A 3-ft diameter Schlieren system is available for flow observation.

The transonic working section and plenum chamber are located in tandem with the supersonic section, and the manually adjusted three-plate diffuser discharges the air to atmosphere at a 10-ft diameter outlet.

The tunnel performance range is summarized in *fig. 2*, showing stagnation pressure limits against Mach number, and the corresponding Reynolds numbers. The available running time varies from 12 to 40 seconds for normal complete model tests but is rather less at the extreme operating pressures. *Fig. 3* shows a typical model, with sting and six-component strain gauge balance. It is anticipated that the nozzle strength limit pressure may be used on component models to give mean chord Reynolds numbers up to 30 or 40 million.

Supersonic nozzle design

On the aerodynamic side of this problem the main difficulty appeared to be that of producing enough design effort from the staff in the wind tunnel department. The choice of method was therefore based on the requirements

(a) that an absolute minimum of separate wall contours be produced covering the range M = 1 to 4.5, and that these should have a family relationship which would permit interpolation to intermediate Mach number contours;

(b) that the bulk of the numerical work should be done on an electronic computer (English Electric DEUCE for preference) with the minimum of new programming.

We were fortunate in being able to call on the experience of the 8-ft tunnel group at RAE Bedford for advice. On both counts there seemed to be little doubt that the conventional method of characteristics was unsuitable (although this has subsequently been remedied), and experimental continuous-curvature nozzle designs at RAE had proved that a family relationship could be achieved only after extensive trial and error exercises. Acceptance of discontinuous curvature at the inflection point would have allowed precise analytical methods to be used to guarantee family continuity, but this would be unacceptable on a flexible plate nozzle.

On the other hand, the Diprose method [1] was already being prepared as a DEUCE programme by RAE. This method enables a wall contour to be determined from any suitably specified velocity distribution along the nozzle centreline. If the equations which determine this velocity distribution are chosen to form a consistent family through the range of Mach numbers, the continuity and smoothness of nozzle contours is ensured. The design resolved itself into four parts, of which the third presented the major difficulty.

1. The main features of the two extreme contours (M = 1 and M = 4.5) were to be determined, including the parameters defining throat curvature, nozzle length, working section height (i.e. 48 in. less boundary layer thickness), which would yield the basic "constants" of the centreline velocity distribution.

2. Expressions were to be derived describing the continuous (and physically consistent) variation of these geometric boundary conditions over the range of Mach numbers.

1. Barritt, Mrs. M.: Calculation of flexible wall shapes for supersonic wind tunnels. R.A.E. Rept. MS 54, 1957.

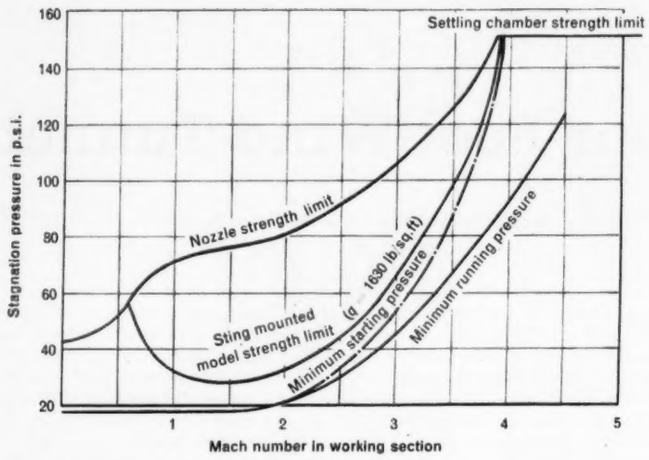
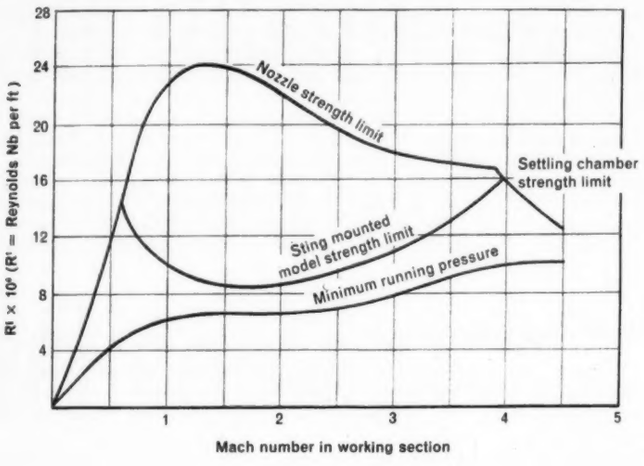

Settling chamber strength limit
Nozzle strength limit
Sting mounted model strength limit (q = 1630 lb/sq.ft)
Minimum starting pressure
Minimum running pressure
Stagnation pressure in p.s.i.
Mach number in working section

Fig. 2: Operating range of wind tunnel.
Upper diagram: The strength of the settling chamber and variable nozzle (or model) is determined by the upper limit of the stagnation pressure; on the other hand a certain minimum pressure is required to maintain the flow (lower continuous curve). The broken curve indicates the initial pressure required to build up the flow.
Lower diagram: Reynolds number range at 288°K stagnation temperature.


Nozzle strength limit
Settling chamber strength limit
Sting mounted model strength limit
Minimum running pressure
R' × 10⁶ (R' = Reynolds Nb per ft)
Mach number in working section

3. A formula was to be determined, giving the variation of velocity along the nozzle centreline, in terms of a set of "constants" which would be computed from the geometric boundary conditions. An important feature of this formula, in addition to the boundary layer conditions at the throat and working section, was the absence of waviness in any form. It was also necessary to ensure that the computed wall curvature would be everywhere smaller than the specified throat curvature (which for high Mach numbers constituted a stress limit on the flexible plate).

4. The wall contours for a "minimum" number of Mach numbers were to be found by iterative numerical solution of the flow equations in the streamline-potential line coordinate system [1]. The rest of the calculation involves simply the addition of a correction of boundary layer growth (obtained by Tucker's method [2] with some numerical smoothing) and the interpolation of coordinates at the actual jacking stations. Since the family of nozzles inherently forms a smooth series, it is sufficient to obtain jack settings for a relatively small number of nozzles; intermediate Mach numbers at close intervals may then be found by interpolation.

The details of the construction in these four stages can more readily be appreciated in the context of the physical configuration *(Fig. 4)*. The nozzle consists basically of a pair of hinged beams carrying the flexible top and bottom walls moving between rigid sidewalls. The upstream end of the beam is built up to form a fixed entry contour in the form of a throat block, and screw jacks at the throat rotate the whole beam about its hinge at the working section. The flexible plates are anchored rigidly to the throat blocks and have sliding hinges at their downstream ends (coincident with the beam hinge points), being freely supported on 18 adjustable jacking stations in between. The beam jacks determine the throat height, and the plate jacks (hydraulically operated against mechanically adjusted stops) determine the contour relative to the beam.

[2] Tucker, M. Approximate turbulent boundary layer development in plane compressible flow, with application to win tunnel design. NACA TN 2045, 1950.

The maximum plate curvature (using 9/16″ Monel plate) was determined as 340 in. radius, and a rough M = 4.5 nozzle was drawn out by the method of characteristics to determine the length (27 ft) and velocity distribution required. The throat block form was also determined at this stage, and the beam schemed out to be horizontal for this Mach number.

For the M = 1 contour, a wall equation was evolved satisfying continuity of the first three derivatives at the entry block, and tending exponentially to a flat wall at the working section (a quadratic exponent was found suitable) —the beam, of course, being hinged out to ensure a continuous contraction.

It was realized at this stage that a progressive displacement of the nozzle throat from the entry block at M = 4.5, to the working section at M = 1 could be defined by progressive rotation of the beam between these two positions (horizontal and roughly 5° convergent); that is, at any intermediate beam angle there would be a point on the plate at which the surface was horizontal in the M = 1 plate configuration. The portion of the plate upstream of this point could remain in the M = 1 contour, whilst the portion downstream would be adjusted to suit a nozzle whose Mach number was given by the area ratio between the throat and working section (see *Fig. 5*). The curvature at the throat would be that given by the M = 1 contour at the same point. In this way the minimum number of jacks would require adjustment for change of Mach number. We had resolved stage (2) by defining all the geometric boundary conditions in terms of a single equation, viz. the M = 1 contour equation. It was then necessary merely to define the set of M-values for which nozzles were to be produced, make allowance for boundary layer growth, and determine the corresponding throat positions, radii of curvature, etc.

Stage (3) of the design was based on an inspection of velocity distribution along the approximate M = 4.5 nozzle designed by the method of characteristics. After some trial and error, an analytic equation was determined, basically of simple exponential form which adequately fitted this velocity distribution and conformed to all the geometric requirements. Certain parameters in this equation could readily be related to the geometric boundary conditions, so that the whole series of nozzles could be defined by this one equation, by suitable variation of these parameters.

The last part of the nozzle design to the stage of producing wall coordinates is adequately described elsewhere [1]. The interpolation of jack-station coordinates is particularly convenient in this method, as the distances along streamlines are produced in the computation, in addition to Cartesian coordinates. The wall streamline distances can readily be converted to dimensions along the flexible plate neutral axis. Addition of the boundary layer correction was, of course, included at this stage.

The number of computed nozzles necessary to ensure adequate interpolation is essentially dependent on the "smoothness" of the final jack settings plotted against Mach number; it was assumed that an adequate guide would be the evidence of smoothness in the variation of boundary conditions. These were inspected not only for absence of waves but for rate of convergence of difference tables.

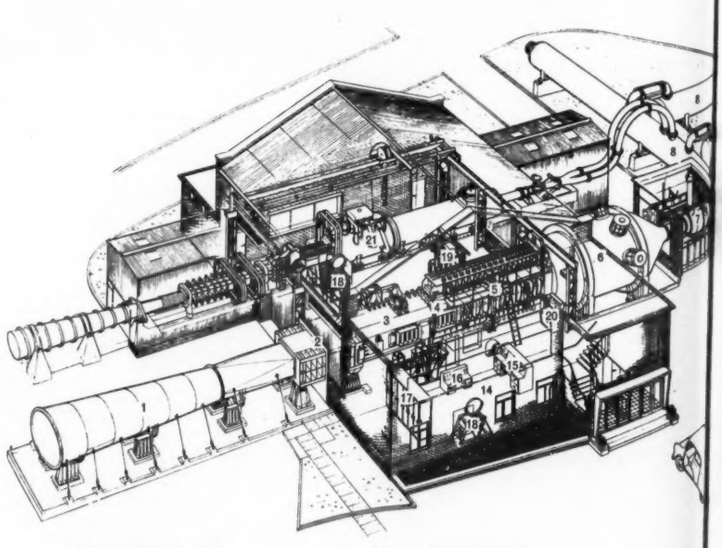


Fig. 1: General view.

1. Subsonic diffuser
2. Supersonic diffuser
3. Transonic working section
4. Supersonic working section
5. Variable nozzle
6. Settling chamber
7. Main control valve
8. Storage vessels
9. Air drier
10. Air coolers and filters
11. Air compressors
12. Electrical substation
13. Water cooling tower
14. Observation room
15. Valve control desk
16. Instrumentation control desk
17. Data-recording equipment
18. Schlieren mirrors
19. Calibrating ring
20. Nozzle controls
21. Guided Weapons Division Mach tunnel

It was originally shown that nine nozzles would be sufficient to obtain accurate interpolations for any Mach number in the range 1.0 to 4.5. However, some difficulties with smoothness did arise in practice at the higher Mach numbers, where the wall shape is very sensitive to small changes in specified velocity distribution. The elimination of these problems was found to involve the computation of a further five contours.

The choice of computation mesh size, on the basis of RAE investigations —and confirmed by a spot check on one of our nozzles—was made to give about 400 intersections in the streamline-potential line network. The ratio of the intervals parallel and normal to the stream direction was determined from the "Diprose condition" that the Mach line must make a greater angle to the stream direction than the diagonal of the mesh; this ensures convergence of errors in the numerical computation.

Tunnel flow control

By the time this problem received any detailed consideration, the main geometric features of the tunnel had already been settled, as also had the operating pressure ranges.

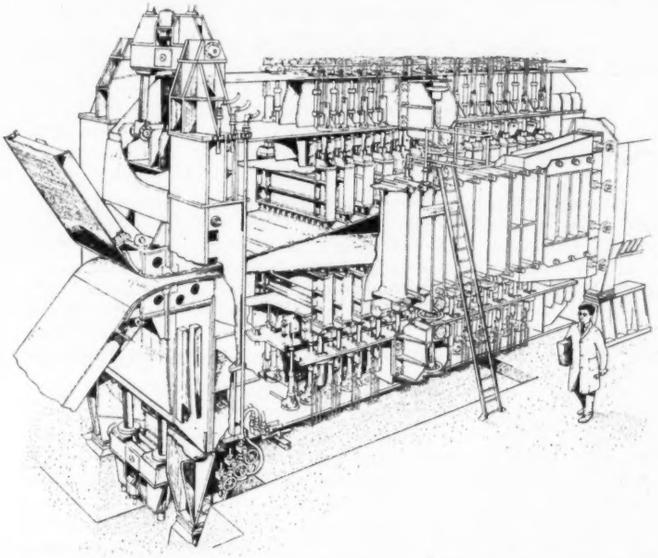
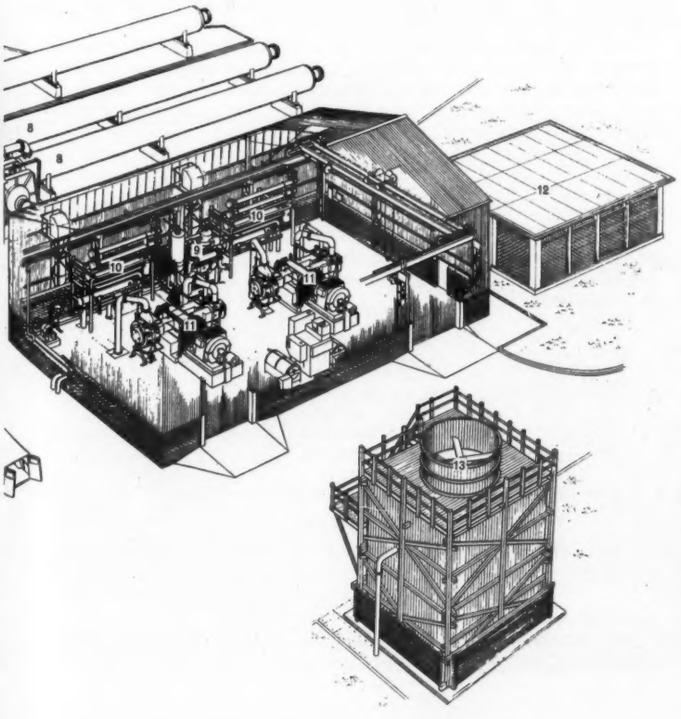


Fig. 4: Sectioned drawing showing arrangement of flexible wall nozzle. The nozzle inlet (left) has a fixed contour, though its section can be varied by hydraulic jacks. The geometry of the nozzle is determined by two flexible plates, which can be set for the desired Mach number by means of 18 jacking stations.



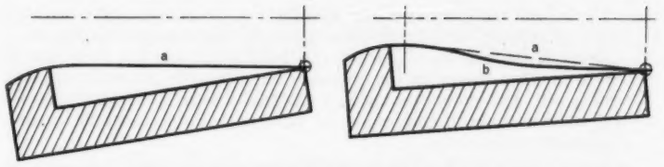


Fig. 5: Positions of beam and flexible plate for two different Mach numbers: left, Mach 1; right, Mach 2. Only the lower half of the nozzle is shown in the diagram (nozzle axis in broken line). The setting of the beam (hatched) determines the area of the nozzle inlet; the contour of the rest of the nozzle consists of a flexible, hydraulically variable Monel plate (a—nozzle contour corresponding to Mach 1; b—nozzle contour corresponding to Mach 2).

Fig. 3: Typical model with sting and six-component strain gauge balance.

The air storage system, as mentioned above, has a volume of 10,000 cu. ft. at 600 p.s.i. At the outlet of each of the four vessels containing this volume, a thermal mass of steel equivalent to the thermal mass of air in each vessel is installed in the form of a matrix of plane and corrugated sheets. As the vessel pressure drops during a run there is an adiabatic cooling of the remaining air; on emerging through these heater matrices, however, heat is transferred to restore the air temperature at the outlet to atmospheric. At the control valve inlet, therefore, the pressure varies adiabatically, according to the mass discharge, whilst the temperature remains constant.

The settling chamber diameter was determined by contraction ratio requirements (10 : 1) at M = 1; the chamber was made just long enough to house the necessary settling screens and a set of relief valves to safeguard the tunnel against control-valve failure; a volume of 4,500 cu.ft. resulted. The nozzle throat area varies over the Mach number range from 16 sq.ft. at M = 1 to 0.8 sq.ft. at M = 4.5, with required tunnel stagnation pressures in the ranges shown in fig. 2. The mass flow of air varies from 450 to over 3,000 lb/sec.

The quasi-static requirements

If we ignore the transient motions of the control valve which would be necessary to establish a given pressure in the settling chamber at a given Mach number, the control requirements for the remainder of the run demand that the control valve effective area should vary inversely to the reservoir pressure. Thus as the pressure falls, the valve must open progressively; detailed analysis shows that the rate of opening increases rapidly towards the end of the run. This implies that the size of control valve must increase rapidly for relatively small gains in running time if it is required to make use of the maximum possible proportion of the air stored. As a compromise between the requirements of maximum running time and an economic valve size, a fully open valve area of 7½ sq.ft. was chosen.

It was also noted from the analysis that a very large variation in valve velocity would be encountered; this ranged from 0.005 sq.ft/sec at the start of a high Mach number run to 4 sq.ft./sec at the end of a run at M = 1. Clearly, the driving system would require an extremely high resolution, and only a hydraulic drive could possibly cover this speed range. Even using the largest available hydraulic servo-valve, it appeared unlikely that a high accuracy of control could be achieved unless the large velocities were in some way separated from the closed-loop pressure control system. It was decided, therefore, that a dual coarse-fine system should be employed. The criteria set down as a basis for the physical design of the system were therefore as follows:

(i) The valve should have two moving components, each capable of closing independently for maximum safety.

(ii) One component would be capable of performing the basic motions required to maintain constant mass flow to an accuracy of 5 to 10%. An open-loop servo with reservoir pressure input was envisaged.

(iii) The second component would operate in a closed-loop servo with an input of required settling chamber pressure. The loop gain of this servo should be made as far as possible independent of reservoir pressure and valve opening, to enable the optimum stability to be achieved throughout a run. This component would essentially require a high frequency response, and would be used (in the servo-loop) to perform the starting transient requirements.

(iv) In view of the danger of control failure or instability at the start-up (i.e. when the reservoir pressure is maximum), a mechanical limitation on the initial valve open area should be incorporated, this limitation being progressively withdrawn as larger areas come into demand with the fall of reservoir pressure.

The mechanical arrangement

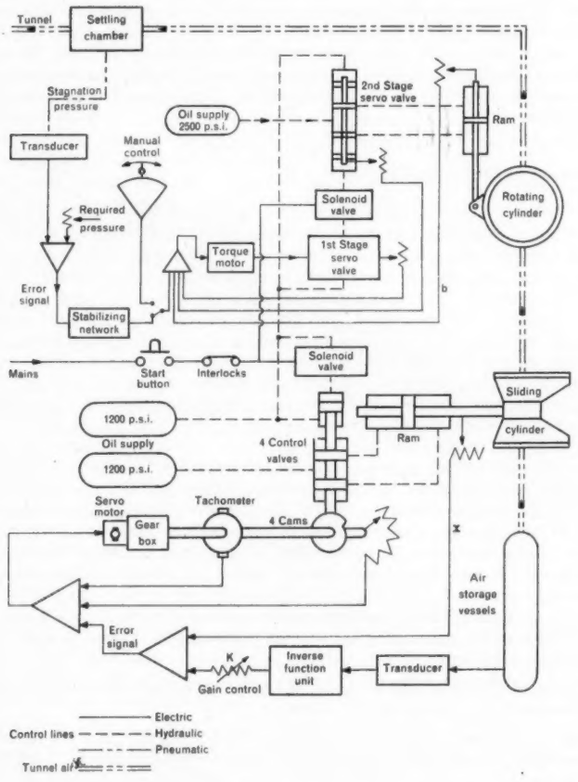
An exploded view of the control valve is shown in *fig. 6*. The inner high-pressure chamber is connected to the reservoir, and contains six rectangular ports round its circumference. Within this cylindrical vessel is an axially driven hollow piston which controls the length of port opening; this is the coarse controller regulated to give an opening inversely proportional to reservoir pressure.

Secondly, there is a rotating ported cylinder surrounding the high-pressure cylinder; this has 30° rotation to vary the open width of the ports. The width of port opening will depend on the required settling chamber pressure set up as the input to the servo system. This width would be nominally constant following the starting transient but, in practice, will vary somewhat due to temperature changes, variations in discharge coefficient, pressure losses etc.

The control circuit block diagram shown in *fig. 7* indicates the general system arrangement. The cam-controlled hydraulic valves for the sliding cylinder deliver 450 g.p.m. fully open. They operate in sequence as increased flow is demanded, the first being a small valve for accurate creeping control. Opening motion only is controlled, closing being achieved by withdrawal of the valve pistons from the camshaft by auxiliary rams, on de-energizing of a solenoid valve. Camshaft position and tacho-feedback are provided for stabilization, the system being slightly over-critically damped.

The rotation cylinder control is based on the 100 g.p.m. two-stage servo-valve, and involves four feedback loops—first and second stage of the servo-valve, ram position, and finally settling chamber pressure. This system was finalized on the basis of analogue computer studies on the servo-response together with other factors discussed briefly below. A fail-safe solenoid valve causes closure, overriding the servo-valve input.

Fig. 7: Schematic of control system.



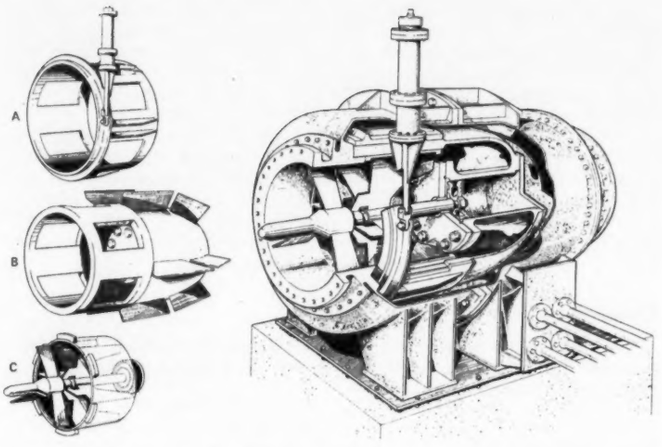


Fig. 6: Sectioned drawing of the pressure control valve. A—outer rotating ports for fine control, B—fixed ports, C—axially driven piston for coarse control and starting.

The starting transient and stability

It is clear that, to achieve a given pressure in the settling chamber in the minimum time (and with minimum waste of air), the valve should initially be opened to a maximum area consistent with safety. Partial re-closure would then be required as the pressure approached the required level. Furthermore, it is obviously desirable that this transient motion should be automatic and not dependent on the correct setting-up of a calculated time-programme. The advantage of the dual control arrangement becomes apparent when condition (iv) of our requirements (start-up safety) is considered.

By suitable choice of the control parameters in the sliding cylinder system, it has been found possible to limit the initial opening of this component so that even complete failure of the rotating cylinder control will not create a dangerous situation. On the other hand, sufficient open area is obtained to give adequately rapid start-up (½ second at low pressure rising to about 2 seconds at M=4, 150 p.s.i. stagnation pressure). By arranging that the sliding cylinder opens a few seconds before the rotating cylinder, we have ensured that any control failure of the former component can be detected in good time and the run stopped. Fortunately, it has also been found possible to use a constant set of control parameters in the sliding cylinder system over the complete range of normal tests. Not only does this reduce the risk of incorrect setting-up of the system, but it is also ideal from the servo-stability point of view. The degree of damping obtained in the response of the servo system to small disturbances is, in fact, independent of both operating pressure and Mach number under these conditions—at least to a first approximation.

The complete stability analysis and practical check-out involved fairly extensive theoretical and analogue computer investigations, which are outside the scope of this article. These studies have, however, fully justified our concept of the control valve as a tailor-made component of the flow control system.

Various facilities have been incorporated to extend the versatility of the tunnel for special purposes. For example, the required pressure in the settling chamber may be switched from a "starting" value to a different "running" value; a "ramp demand" may be fed into the system to provide steadily rising pressure at various rates; manual control of the rotating cylinder may replace the servo control; and spot checks on the control systems may be carried out on either component, leaving the other component closed for safety.

We may summarize our approach to this flow control problem as follows:

(a) The two fail-safe components of the valve ensure maximum safety;

(b) The coarse-fine control system ensures maximum accuracy under rapidly varying reservoir conditions;

(c) The danger of excessive valve opening on start-up is automatically avoided;

(d) The operators have basically only one parameter (required pressure) to set up for a run, with the minimum chance of error.

Acknowledgments

The author is indebted to the English Electric Aviation Co. Ltd. for permission to publish this paper, and for the use of diagrams.

The Czechoslovak PCK-55 Jet Training Simulator

by Engineer Jaroslav Švanda, Brno

At the 1st International Trade Fair held in Brno in September 1959, the Czechoslovak foreign trade organization Omnipol demonstrated the PCK-55 jet training simulator, a training cockpit with a wide range of accessories. *Fig. 1* shows a general view of the full equipment, which includes the single-seat cabin (rear), the instructor's control desk (right foreground) and the plotting table (left), the circular "air situation" table and a supplementary equipment for target practice with aircraft weapons. The latter equipment consists of a film projector with lateral control mechanism and a screen.

The framework of the cabin is of wooden construction, fabric covered, and no attempt has been made to simulate wings or tail surfaces. The cabin is mounted on a gimbal bearing, so that it can move freely about all three axes. An electric motor, controlled by two potentiometers coupled to the cabin controls, turns the cabin about the vertical axis, while banking and fore-and-aft inclinations are controlled by four air bags in cruciform arrangement and operated from the control column *(see fig. 2)* via valves which connect them either with a suction pump or with the outside air. The suction pump and its motor (power 2.4 kW at 2,800 r.p.m.) are normally housed in a neighbouring room. The pump, a six-stage radial design operating at 6,300 r.p.m., produces a vacuum equivalent to approximately 6 inches of mercury.

As the flight simulator is designed primarily for training pilots of single-seat jet aircraft, the internal layout of the cabin—in particular of the instruments—corresponds to that of a fighter *(fig. 3)*. The scale on the airspeed indicator, for example, extends to 1,200 km/h (650 knots), that on the altimeter to 15,000 m (50,000 ft), and the rate of climb indicator shows vertical speeds up to 75 m/sec (14,760 ft/min). On top of the instrument panel is a gun sight, to the left of which is a magnetic compass, and to the right a stop watch. The throttle lever in the left cabin wall carries a twist grip with the aid of which the span

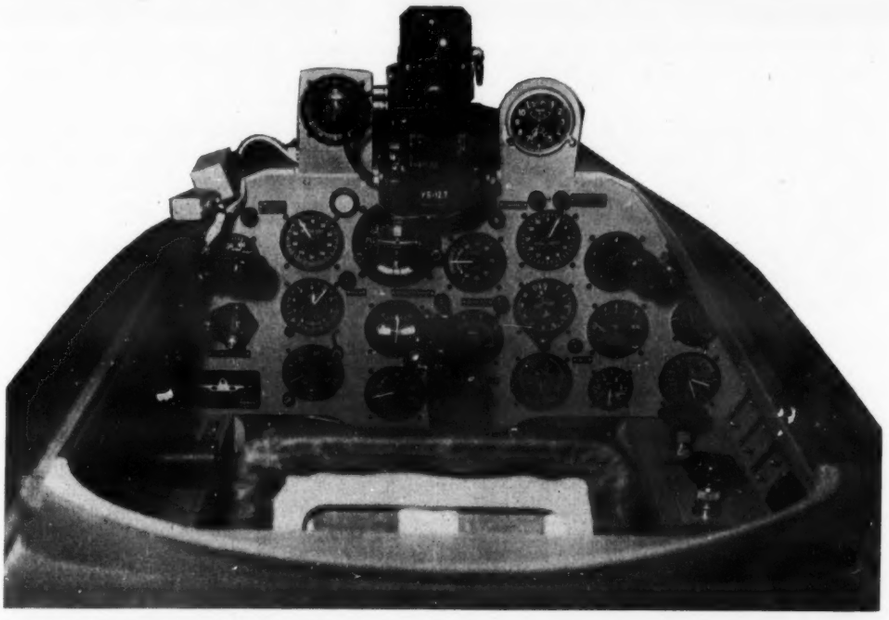


Fig. 3: The instrument panel in the simulator.

Fig. 1: PCK-55 flight simulator with accessories.

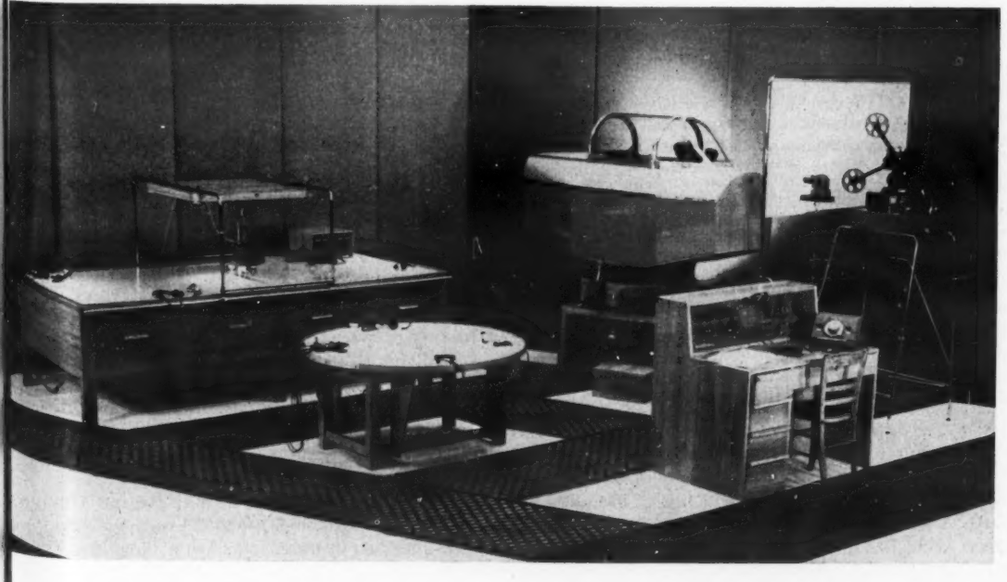
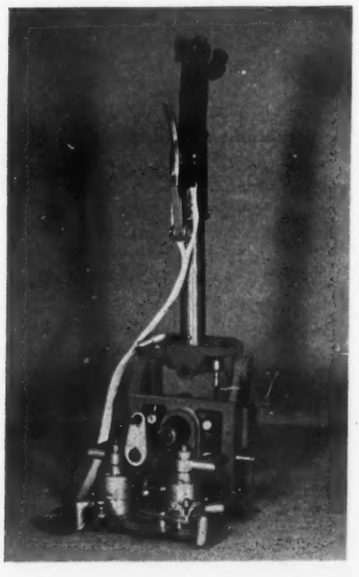


Fig. 2: The control column is connected with pneumatic valves for banking and fore-and-aft control of the cabin.



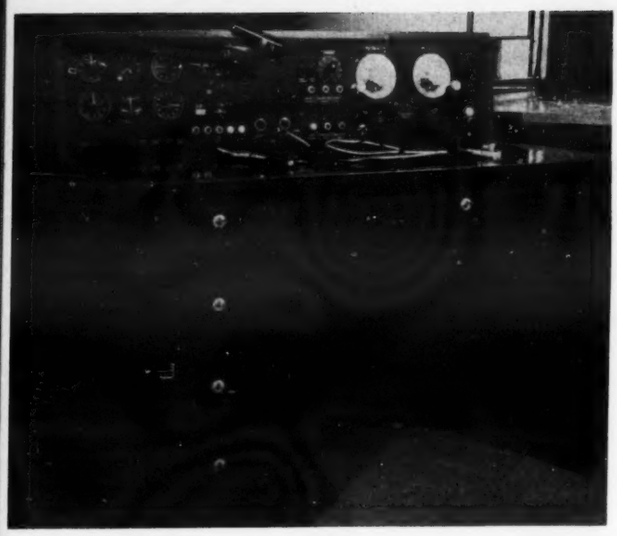


Fig. 4: Instructor's control desk.

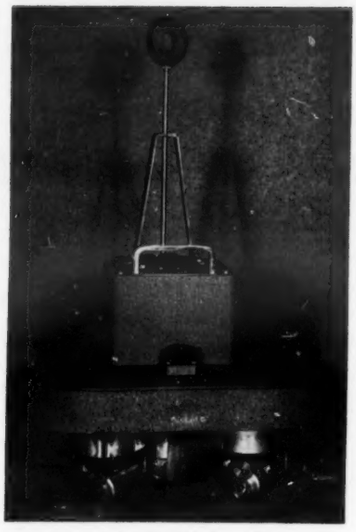


Fig. 5: Crab for reproducing "flight movements" and "taking bearings from radio beacons."

of the aircraft silhouette on the sight can be "framed" for the purpose of calculating target range; a push button on the side of the grip switches on radio communication with the instructor.

The *instructor's control desk (fig. 4)* contains repeater instruments for altimeter, rate of climb indicator, turn-and-bank indicator, airspeed indicator, radio compass indicator and undercarriage indicator, to enable the instructor to check the pilot's actions. In addition, the instructor can adjust simulated wind speed and direction at will.

The *plotting table* carries a 1:200,000 scale map on which an overhead crab inscribes the simulated flight path of the aircraft, while a second device inside the table shows the position of the target by projecting a silhouette on the glass surface. The movement of the upper crab *(fig. 5)* is controlled by an autosyn. The crab also carries a second autosyn connected with a small D/F antenna. The relevant five "radio beacons" are housed in a flat travelling box above the plotting table.

Finally, the *circular table* provides a display of the air situation and is used for the training of fighter control personnel. It is fitted with the necessary telephone lines. With the aid of the *supplementary equipment* the most difficult flying and navigational exercises can be combined with visual target attacks on simulated enemy aircraft. The projector for 16-mm film throws the image of an aircraft, whose size and attitude is constantly changed, onto a background of clouds.

The pilot attacks his air target on a so-called curve of pursuit, at the same time practising target recognition and correct handling of the sight, as well as the actual attack. The result of these operations is calculated by two computers in the control desk, one of which gives the number of rounds fired, the other the number of hits recorded.

Thus the Czechoslovak PCK-55 jet flight simulator meets all the requirements for a modern flight training equipment: training in pilotage; navigation flights with or without ground radio equipment, in particular handling of the radio compass; cooperation between pilot and ground control station; and last but not least attack on air targets.

Bonn Discusses Air Traffic Control Problems

Just before printing deadline for this issue, a meeting of two Parliamentary Committees took place in Bonn, at which a number of air traffic control problems were discussed. As these problems are not confined to West Germany, but have arisen in the same or related form in practically every country of the world, a member of the Interavia *staff, well versed in air traffic control matters, attended the meeting. His report follows below.* Editors.

Can the air traffic control services continue to carry out their tasks and ensure the safety of aviation, despite acute personnel shortage and many other difficulties?

Such, in effect, was the basic question raised at the joint meeting of the Bundestag Transport and Defence Committees held in Bonn on November 10th, 1960, which was also attended by representatives from the civil traffic control authorities and the Luftwaffe. Such a discussion between the two Committees had long been urged and was finally organized as a result of the reported near-miss between two jet fighters and Queen Elizabeth's *Comet* on October 25th. The reply to the oft-repeated cardinal question of whether aircraft operators are sufficiently protected against mid-air collisions was in no way surprising, but also did not altogether disperse the doubts which have been expressed with increasing frequency in recent months. The personnel problem—one of the biggest difficulties encountered throughout the world—took pride of place in the discussions, which naturally were not able to cover all the relevant questions in the brief hour and a half available.

According to the figures supplied by the Transport Ministry, there were in the Federal German Republic on October 15th, 1960 a total of 623 licensed air traffic controllers, and another 125 students were undergoing basic training at that date. The existing personnel therefore does not even suffice to fill the 850 posts allowed for under the 1961 budget. Despite the shortage of trained personnel, the training standard was good, it was added, and the controllers were doing their best to ensure the maximum degree of safety with the available resources. But there was just not enough control staff "for normal conditions," and controllers were therefore overburdened in their highly responsible work. And any overstrain, however small, must inevitably have many and varied effects on the "infallibility" demanded of the air traffic control services.

The acute shortage of personnel is the reason why existing radar equipment cannot be adequately manned and why working hours for civil controllers are far too long. According to a Transport Ministry statement, the majority of civil air traffic control radars are manned only during daylight hours—the hours of densest traffic—the only notable exception being Frankfurt approach control which is in operation day and night. The way the personnel situation is shaping at the moment, full 24-hour operation of all radar equipments cannot be expected before the end of 1961 at the earliest.

In this context it was stressed that the safety of air transport was *not* affected by the shortage of radar equipment and radar personnel. The control of air traffic by conventional procedures, which has been practised for many years, was described as entirely reliable and quite adequate for light traffic. However, the employment of radar enables more rational use to be made of the airspace, the flow of traffic to be made more orderly, and hence uneconomic delays to be avoided—in other words it enables the air traffic control services to meet the increasing demands made upon them by the air transport industry.

There can be no denying the fact that the military traffic control service is better off as regards personnel than the civil. This was revealed, for example, by the statement that the Luftwaffe's controllers are relieved after not more than two hours at the radar equipments and placed for a time on other, less straining work. In the civil traffic control centres, however, the radar controller must sit in front of his set for up to eight hours, despite the fact that doctors and psychologists showed early this year that after two to three hours at the radar screen

efficiency and concentration fall off very rapidly. If work is continued for a longer period without adequate relaxation, the likelihood of errors grows to an extent which cannot be reconciled with safety requirements. The Federal Air Traffic Control Establishment plans, it was stated in Bonn, to organize an investigation of these problems and to base its future action on the results obtained.

On the question of training it was remarked that at the present time civil and military traffic controllers are trained at separate schools, but that joint training is aimed at in the future. This, however, would not be possible until an air traffic control school of adequate capacity was available. It was also planned to give future air traffic control trainees the basic amount of flying training essential for the performance of their control duties. Training, however, would be broken off before the issue of a pilot's licence, so as to avoid the obligation to maintain the licence.

Of late there has been a growing demand in West Germany for an efficient central Federal aviation authority, a subject which was also briefly touched upon at the Bonn meeting. The fact that responsibility for aviation matters is divided among the individual Länder, it was argued, has a bad effect on the air traffic control services. This argument, however, was rejected by the Government representatives, who maintained that the establishment of a new central authority for air traffic control was not in the public interest and would merely delay the solution to the present burning questions. The demarcation between Federal and Land responsibilities was quite clear already, and everybody knew where he was.

One statement which attracted considerable attention was that neither funds nor personnel had so far ever been refused for purposes of military air traffic control. Here the speaker was unmistakably addressing the civil air traffic control authorities (who have blamed cuts in earlier years for the present personnel shortage) when he pointed out that, though the Federal Audit Office and the Office for Administrative Economies could make recommendations, they had no power to impose cuts or in any way reduce the responsibility of the specialized agencies.

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The Bundestag Committees are, of course, composed of parliamentarians, that is, of politicians. It cannot therefore be described as particularly surprising that party politics should have crept into the Committees' discussions. Since it is difficult for a politician to form an objective picture of the complex questions involved in air traffic control, the danger is great that, if political interests are introduced into the discussion, the heart of the problem is ignored. Such was the impression left by the Bonn meeting, which led to no new decisions. However, a remark made by the Chairman (in a private conversation after the meeting had closed) struck a more hopeful note: these matters, he said, must be taken very seriously, and a great deal more attention must be given to them.

One other point is worthy of note: this was the first time since the establishment of the German air traffic control services after the war that air traffic controllers had been called as expert witnesses to testify before so high a committee. Can this be taken as a sign that air traffic control affairs in Germany will no longer be settled exclusively behind the closed doors of the Transport Ministry and its air traffic control authority, as has hitherto been the case ?

It is not only in Germany that air traffic controllers have long been treated as tiresome pessimists. But it has now transpired that the warnings uttered by these key air transport specialists are justified, a fact which is undoubtedly helping to raise the controllers' prestige. The associations of air traffic controllers which exist in many countries have set the maintenance and improvement of aviation safety as their goal and have thus proved that their members rate the interests of aviation above their own.

A federation of European air traffic control associations is shortly to be established, and the delegates from 26 countries who attended the First International Air Traffic Control Conference (organized by the U.S. Air Traffic Control Association) at San Francisco in early October this year unanimously agreed that all professional associations should combine to form an international organization. There can be no doubt that—like IATA in its own domain—the projected IFATCA (International Federation of Air Traffic Control Associations) can perform very useful work for the well-being of the traffic control services.

Book Reviews

Aerodynamik des Flugzeuges, Zweiter Band. Aerodynamik des Tragflügels (Teil II), des Rumpfes, der Flügel-Rumpf-Anordnungen und der Leitwerke. By H. Schlichting and E. Truckenbrodt. Springer-Verlag, Berlin-Göttingen-Heidelberg, 1960 (German; XVI+485 pages; 389 illustrations; clothbound, price DM 61.50).

This second volume of the basic textbook on the aerodynamics of aircraft by two writers whose names are well known far outside the German-speaking countries, continues from where the first volume (published in 1959) left off. The first two chapters complete the earlier portions on wing theory (The Wing of Finite Span in Incompressible Flow, and The Wing in Compressible Flow), while the remainder of the book is devoted to a discussion of the aerodynamics of the fuselage and tail surfaces. Considerable space is given to the question of interaction between the fuselage and wing configurations, a subject which has received but summary treatment in most other comparable works. The clear arrangement of the subject matter, consistent use of exactly defined terms, accurate and detailed deductions, ample numerical examples and wealth of illustrations give the book a value far beyond that of a mere textbook. The two volumes, which could well be combined to form a single handbook, fill a long-felt need in German technical literature, a need which has been all the more striking in that Germany played a decisive role in the development of aerodynamics from the earliest days. List of references at the end of each chapter, an overall bibliography, an annex containing aerodynamic parameters, a list of personalities and a subject index complete the work. P.r

Weather Forecasting for Aeronautics. — By Joseph J. George (Eastern Air Lines) and seven collaborators. Academic Press, New York and London, 1960 (English; 673 pages; numerous diagrams and maps; price $15.00).

In his foreword, the author remarks with some justification that most books on weather forecasting lay too much stress on theory and thus give the practical man relatively little aid in solving his day-to-day problems. Naturally, he must have a thorough knowledge of the principles of physics to be able to understand the major outlines of weather phenomena; but what heads of air services, pilots and navigators need is a comprehensive empirical presentation of the facts with as many practical examples as possible. And this is generously supplied by the author, a member of Eastern Air Lines. Nearly every one of the eighteen chapters in his handbook contains numerous weather maps as used in scheduled airline operations, and detailed descriptions of individual situations leading to a better understanding of this complicated subject. The reader is spared indigestible mathematical formulae. A short, well-illustrated section is devoted to the "met man's" newest aid, weather radar. There are also chapters on the following subjects: Construction of the Prognostic Pressure Chart; the Prediction of Cyclogenesis; Displacement of Surface Cold Fronts; Warm Frontal Analysis and Movement; The Movement of Tropical Cyclones; the "Poor Man's" Numerical Weather Prediction System; Synthesis of a Prognostic Chart; the Prediction of Very Low Ceiling and Fogs; Pre-Trough Winter Precipitation Forecasting etc. With this clearly written work, Joseph J. George has rendered flying personnel an invaluable service. He.

Taschenbuch für Atomfragen 1960/61. Edited by Dr. W. Cartellieri, Dr. A. Hocker, Dr. A. Weber and Dr. W. Schnurr, with an introduction by Professor S. Balke, Federal Minister of Nuclear and Water Power. Festland Verlag GmbH, Bonn, 1960 (German; 438 pages; pocket size; plastic cover; price DM 14.—).

The second edition of this yearbook, enlarged and rearranged, which gives highly reliable information on all aspects of the peaceful use of nuclear energy in the Federal German Republic, was completed after the passing of the German Atomic Law. The clearly arranged, thumb-indexed sections contain informative subjects: The structure of the German atomic authorities; international cooperation; research; technology and economics; radiation shielding; legislation; "The German Nuclear Forum"; nuclear ABC (an alphabetically arranged explanation of the most important terms in nuclear science and technology); list of suppliers; register of names and addresses etc. The chapter "Blick über die Zonengrenze" deals for the first time with the state of nuclear research and technology in the German Democratic Republic. Indispensable to all those concerned with the German nuclear industry. He.

Antarctica. — A picture volume by Emil Schulthess. Foreword by Sir Raymond Priestley. Artemis-Verlag, Zurich, 1960 (German; 173 photographs, the majority in colour; price 58 Swiss francs).

The Antarctic expeditions carried out during the 1957/58 International Geophysical Year are given an artistic memorial in this book. Emil Schulthess reports on life at the various stations of the American Antarctic expedition, with which he spent more than four months studying and photographing landscape, flora and fauna of the seventh continent.

Needless to say, the most advanced technical equipment played a decisive part in this tremendous undertaking, which cost the United States a quarter of a billion dollars. Sir Raymond Priestley, who took part in the 1908 Shackleton expedition and was a

member of Scott's crew on the "Terra Nova" in 1910, writes in his foreword: "The use of aircraft in the Antarctic has become commonplace. When we flew to Marble Point to inspect the site for a two-mile runway, several *Dakotas*, *Neptunes*, *Otters* and helicopters were standing side-by-side on the strip at McMurdo. An imposing sight, which will be even more striking when the giant 90-ton *Globemaster* freighters begin to land here."

The artistic and technical quality of the photographs, the general presentation and the quality of the printing are outstanding and make the book one of the most handsome documents on Polar research and a revelation for every photographer. Fi.

Konstruktion und Fertigung/Design and Production. — By Max Bremberger. R. Oldenbourg, Munich, 1960 (German/English ; 276 pages plus appendix of 68 engineering drawings; cloth-bound; price DM 44.00).

American engineering drawings differ in several respects from German, and often contain a large number of abbreviations and references which present difficulties even to engineers with a good knowledge of the English language. The present handbook is designed to overcome these difficulties, and the author covers all the questions arising in this connection, treating all technical expressions in their proper context. His topics range from presentation in general (which for some reason he calls "representation") via measures, symbols and standards (including those of the National Aircraft Standards Committee) to working drawings. There follow tables, a list of abbreviations and an extensive German-English and English-German glossary. The appendix contains a series of engineering drawings with explanations in two languages. With the growing number of American products which are manufactured under licence in Germany, this book should provide valuable assistance. De.

Tout pour la Ligne. — By Raymond Vanier. Editions France-Empire, Paris, 1960 (French; 302 pages).

If anyone is entitled to give his memoirs so proud a title, it is certainly Raymond Vanier, who has devoted his whole working life to the "Ligne," who helped build up the first French overseas airline and played a decisive part in the entire course of French air transport history. A successful military pilot in World War I, he joined Lignes Aériennes Latécoère immediately after the Armistice in the company of such famous names as Didier Daurat, Jean Mermoz, Henri Guillaumet . . . was among the first to cross the Mediterranean and then the South Atlantic, served as Chief Pilot with Air Bleu, as manager of Aéropostale and as airmail boss of Air France. The organization of the French airmail services, and particularly of the night services, is his work. "The night mail service," he writes in his autobiography, "has taken up so large a part of my life that I am tempted to reproduce in full here the some four to five hundred pages of notes which I have jotted down night by night and which I preserve like a treasured logbook. These pages represent nearly fifteen years of unceasing struggle against an implacable enemy, fog."

Raymond Vanier conquered the fog. He came through many a battle against faintheartedness and lack of enterprise among others and against the despondency which sometimes assailed himself. When on January 30th, 1959 he handed over his last sack of mail to one of his captains before retiring, he could report with justifiable pride "mission terminée." And today he presents his memoirs of men, aircraft and institutions, memoirs which, though highly personal, basically coincide with the history of France's air transport industry. Anyone who is interested in this history should certainly read this book. He will definitely not find it boring. He.

International Missile and Spacecraft Guide. — By Frederick I. Ordway III and Ronald C. Wakeford. McGraw-Hill Book Company, Inc., New York-Toronto-London, 1960 (English; 420 pages; 861 illustrations; clothbound).

Beginning with the invention of gunpowder by the Chinese around the year 1200, the authors recount the whole history of rocketry up to the present day. A general introduction to the various types (surface-to-surface, surface-to-air, air-to-surface and air-to-air missiles and rocket aircraft, spacecraft, drones and research rockets) is followed by examples of early developments. The chapter on space research vehicles gives details of artificial satellites, space probes, propulsion systems, instruments and research objectives. The text is supplemented by a large number of photographs (including some unusual shots) and clear drawings. The second part of the book describes present-day missiles, research rockets and spacecraft. A list of addresses of important agencies, service units, research organizations, etc. connected with rocketry, a bibliography and an index complete this handbook, which the reader will find difficult to put down. It should find its place next to Jane's in every self-respecting aviation and astronautics library. De.

Space Biology: The Human Factors in Space Flight. — By James Stephen Hanrahan and David Rushnell. Basic Books, Inc., New York, 1960 (English; 263 pages; boards; price $5.00).

This is a popular scientific work on the development of space biology and may possibly not meet with the unanimous approval of all specialists. It is, nevertheless, highly welcome, since the authors, who work at the Historical Division of the U.S. Air Force Missile Development Center, have the gift of making their somewhat forbidding subject accessible even to those whose interest in aviation and astronautics is purely incidental; they realize that it is possible to write seriously without boring the reader. Despite the lively, gripping presentation and the brevity which is partly a matter of necessity, all the subjects are dealt with conscientiously, even though the authors base their book less on works of aviation medicine than on articles in newspapers and periodicals of a less specialized nature.

On the eve of manned space flight it is becoming increasingly urgent to give the general public a notion of the possibilities and difficulties of future expeditions. It is our duty to learn of the torments to which man and beast must be subjected to ascertain the limits of endurance for future astronauts. The authors systematically investigate all the environmental conditions: pressure, cabin acclimatization, food problems, the influence of accelerations and decelerations (with practical experiments on centrifuges and sleds), weightlessness, temperature and radiation effects, pressure suits, etc.

The volume closes with the words: "Man indeed is going into space. Although still earth-bound, he is learning more and more each day about solving the problems of human space flight. Ultimate success is certain. And success in the exploration of alien portions of the universe will change the very nature of our lives." He.

Handbuch der Astronautik, volume 1, issues 1 to 4. — Edited by Karl Schütte and Hans K. Kaiser. Akademische Verlagsgesellschaft Athenaion, Dr. Albert Hachfeld, Konstanz, 1958 and 1960 (German, English; 128 pages; price per issue DM 5.20).

It says much for the enterprising spirit of editors and publishers that they are embarking upon a handbook of astronautics at a time when space research is proceeding at a headlong pace. The first article, "Die Geschichte des Raumfahrtgedankens," by the well-known rocket technician Willi Ley, is of absorbing interest. Based upon quotations from works on natural science and history, novels, periodicals and patents, the article spans a period ranging from antiquity to the present day, casting a new light on many things which the first ventures into space have now led us to take for granted.

Next, Werner Schaub gives an uncompromisingly mathematical, yet highly comprehensible account of the principles of the mechanics of the heavenly bodies: gravitation, the fields of gravity of two masses, the curves of trajectories in space. John Cobb Cooper, internationally known through his contributions to air law, sees in the Paris and Chicago Conventions examples of the peaceful solution of problems of international law which could serve as models in the establishment of a space code. Alfred J. Zaehringer deals with solid rocket techniques and combustion problems. Hermann Stümke gives some examples of the calculation of rocket trajectories within the earth's gravitational field, taking account of atmospheric influences. Finally, there is an article on heat transfer problems in liquid-propellant rockets, by Shirley J. Smith and George P. Sutton.

All the articles, including the technical and mathematical ones, are clear and easily readable. It is to be hoped that this policy will be continued into later issues, thus assuring the handbook of a wide following in the astronautical world. Pr.

Second Colloquium on the Law of Outer Space, London 1959. Proceedings. — Edited by Andrew G. Haley and Dr. Welf Heinrich, Prince of Hanover. Springer-Verlag, Vienna, 1960 (English; 176 pages; price $6.00; $4.80 to members of bodies affiliated to the IAF and subscribers to "Astronautica Acta").

A special section to deal with space law was set up at the International Astronautical Federation Congress in Barcelona in 1957. The first Colloquium on the Law of Outer Space was held in the Hague in August, 1958, the second in London in September, 1959; the result of the third, held in Stockholm in August, 1960, was the foundation of an IAF Institute of Space Law with headquarters in Paris. Even a brief glance at the list of contents of the proceedings will show that the foundations of a future space code are being laid by air and space lawyers of international fame: D. Goedhuis (Netherlands), Prince Welf Heinrich of Hanover and Alex Meyer (German Federal Republic), E. Pépin (France), E. Galloway (USA) etc. He.

First into Outer Space. — By Theodore J. Gordon and Julian Scheer. St. Martin's Press, New York, 1959 (English, 197 pages, price $3.95).

The men in the concrete blockhouse who direct the launching of space rockets are as a rule not writers. It is therefore particularly gratifying to find that Douglas engineer Ted Gordon—who directed early successful launchings from Cape Canaveral—and his co-author Julian Scheer wield the pen as skilfully as the slide rule.

The reader is here taken into the blockhouse with the test team and lives through the same agonizing moments of waiting for success . . . or failure. He shares in the satisfactions and disappointments leading up to the launching of the second American moon probe on October 11th, 1958. This book provides the layman with an excellent initiation into the mysteries of what goes on in the rocket control centres. He.

Nuclear Flight. — Edited by Lt. Colonel Kenneth F. Gantz; Duell, Sloan and Pearce, Inc., New York, 1960 (English, 216 pages, illustrated, $4.00).

This is an exhaustive report on the progress being made by the United States Air Force towards the achievement of nuclear-powered flight. The material has been assembled under four headings: The prospect for nuclear-powered flight; Principles of nuclear propulsion; Status of program; and the Human Element.

The first two sections trace the development of nuclear power sources, and cover power reactors, reactor materials, heat transfer and coolant systems and power production from nuclear energy. The third section then reports on the state of development with respect to direct-cycle and indirect-cycle propulsion, ramjet reactors, ramjet design, radio-isotopic power sources and radiation effects on aircraft systems.

The last section, "The Human Element" is of particular interest as it covers the questions of human engineering for nuclear aircraft, ground support and public hazard. These are new problems which come to light with the development of nuclear propulsion and which must be solved before the nuclear aircraft can be accepted as a practical proposition.

The great interest of this book is that it provides a comprehensive introduction to all the problems of nuclear propulsion and acquaints the reader with the progress to date. The material has been written by over twenty military and civilian experts in this field. They deal with subjects of considerable complexity but they have succeeded in making the subject understandable to the non-specialist reader. K. B.

Auswirkungen des Einsatzes strahlgetriebener Flugzeuge im Luftverkehr. — No. 51 in the series "Technische und volkswirtschaftliche Berichte des Wirtschafts- und Verkehrsministerium Nordrhein-Westfalen." By Professor Edgar Rössger, 1960 (German; 227 pages; price DM 20.00).

This report, which was written at the end of July 1957, i.e., before the general introduction of scheduled jet services, is telling proof of the value of conscientious and expert long-term investigations. Although the author particularly stresses in his foreword

that developments have been so rapid that the report should strictly speaking be rewritten, many of his conclusions and calculations are still valid today, from the point of view of the technical and economic problems involved in both airline fleets and ground organization. Admittedly, full data for the jets now in service were already available when the report was composed. In any case, this volume (printed in manuscript form) forms a valuable supplement to existing documentation on jet transport. He.

Flight Facts for Private Pilots. — By Merrill E. Tower; Aero Publishers, Inc., Los Angeles, 1960. (English; 216 pages; 250 illustrations; price paper back $3.50, boards $5.00).

This book has been prepared and published to meet the needs of the student and private pilot. As it is an American publication it is obvious that it has been written with the licencing requirements of the Federal Aviation Agency in mind. At the same time its coverage is comprehensive and it contains a great deal of general information of practical value to the student pilot, irrespective of which certification authority he will finally encounter.

The book is divided into four sections. The first section deals with the aircraft itself and ranges from the theory of flight to actual flight control and engine handling. Section Two covers meteorology and basic weather science while Section Three is devoted to navigation. The last section is entitled Attitude Instrument Flying, and provides a simple introduction to the mechanics and operation of flight instruments and to instrument flight in general.

The contents of such a book will be referred to frequently in the course of a student pilot's training. It is unfortunate that such a reference book lacks an index to simplify the student's research. Apart from this criticism of the layout, the book will be of considerable assistance to the trainee pilot and also of interest to the aviation enthusiast. K.B.

Foundations of Aerodynamics. Second edition. — By A. M. Kuethe and J. D. Schetzer. John Wiley and Sons, Inc., New York, 1959 (English; 446 pages; $11.75).

The first edition of this book appeared in 1950, with the object of presenting, in a form suitable for classroom use, the foundations on which aerodynamics rests. In the intervening years many technological advances have occurred and the book has now been revised to include these topics. Some deletions have been made and some sections rewritten, so that the contents still provide the essentials for the present-day student of the science.

Nine years' use as a classroom text-book is ample indication of the intrinsic value of the work, and it suffices to mention that the changes in the second edition include a rewritten chapter on energy relations; increased treatment of one dimensional compressible flows and expanded discussion of compressibility in both laminar and turbulent flow.

New graphical material has been added and also a set of problems is included at the end of the book. K. B.

Deutsche Flug-Abwehr im 20. Jahrhundert.— By General (Ret.) O. W. von Renz. — Mittler & Sohn, Berlin/Frankfurt, 1960 (German; 207 pages).

Changes in strategic concepts and the switch-over from manned aircraft to rockets meant that the anti-aircraft artillery fell somewhat into disrepute and was regarded as "dead" in many quarters. What was the use of guns against ballistic missiles, it was argued. Yet the most recent developments—the comeback of the manned aircraft for local conflicts and the advent of the low-level strike aircraft designed to penetrate enemy territory underneath the radar screen—have demanded a revision of this summary judgment. Anti-aircraft artillery has come in for renewed consideration, and the present historical and critical account of all phases of German A/A defences in the 20th century will provide much useful information for future planning. The book also reveals that the author was closely connected with the "Flak" arm right from the beginning: in 1913 he was serving as lieutenant in the first "Balloon Defence Formation," and at the end of World War II he left the military services as General Commanding the 5th Flak Corps. He.

Famous Bombers of the Second World War (Second series). — By William Green; illustrated by G. W. Heumann and Peter Endsleigh Castle. Macdonald, London, 1960 (English; 136 pages; price 21 shillings).

Thirteen aircraft have been selected for inclusion in this second edition of "Famous Bombers of the Second World War." Five British aircraft, three German, three Japanese and two American, have been chosen to demonstrate the pattern of bomber development. The first edition of this book dealt mainly with aircraft which reached maturity during the conflict, while this volume concentrates on those which existed when the war began, or were evolved during the war years and saw action in the closing stages of the struggle.

This method of selection has resulted in the inclusion of such venerable types as the *Whitley* and *Hampden* at one end of the scale, and the *Superfortress* and Arado Ar 234B *Blitz* at the other. It is an interesting illustration of the impetus given by wartime development to note that a period of less than eight years separates the first flights of these dissimilar types.

The book is excellently illustrated both by photographs and drawings, and the text provides a mass of information on the development history of each aircraft. From these histories it is possible to trace the shortcomings of each type in the light of operational experience and to follow the modifications which were required to meet changing needs. Such a comprehensive record of aircraft development is always a valuable addition to a library of aviation history. K. B.

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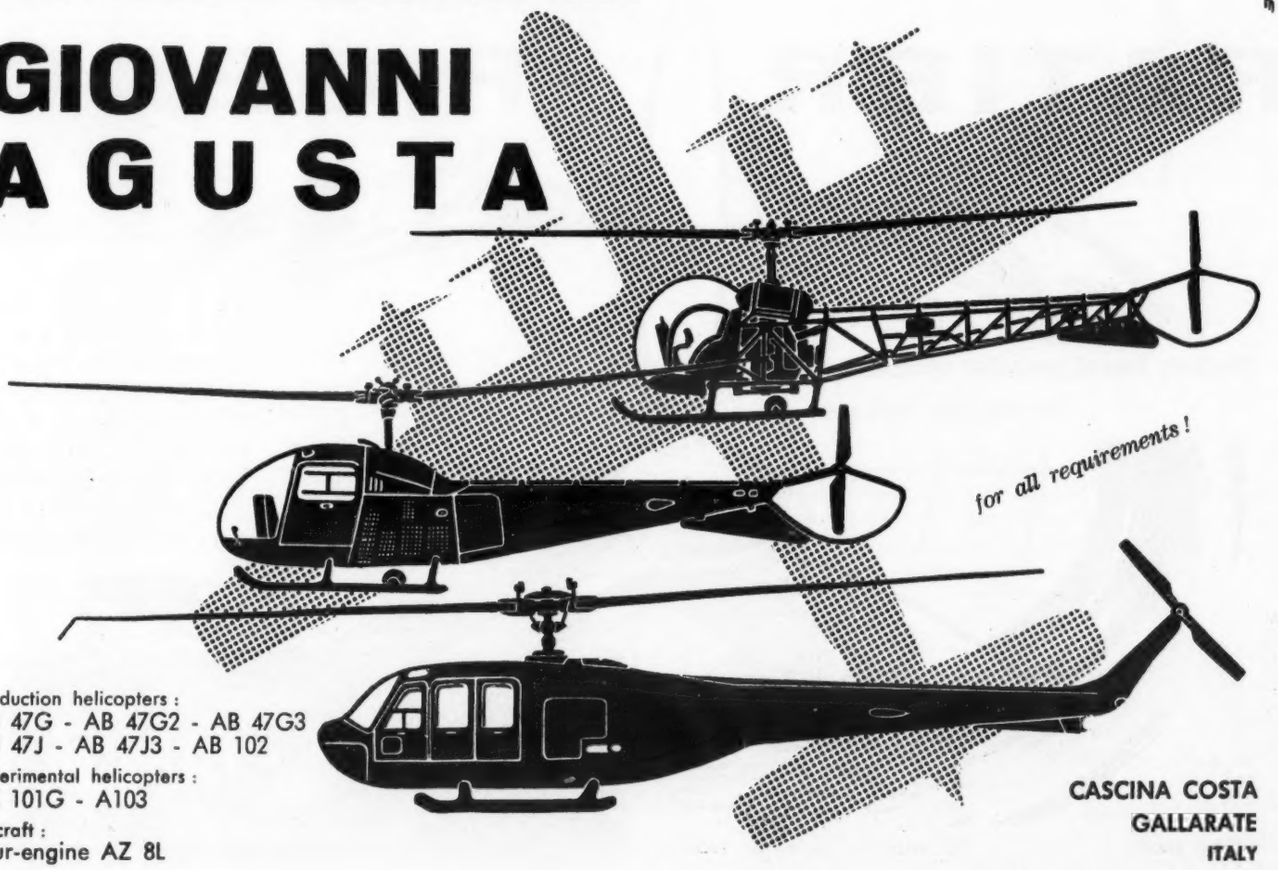

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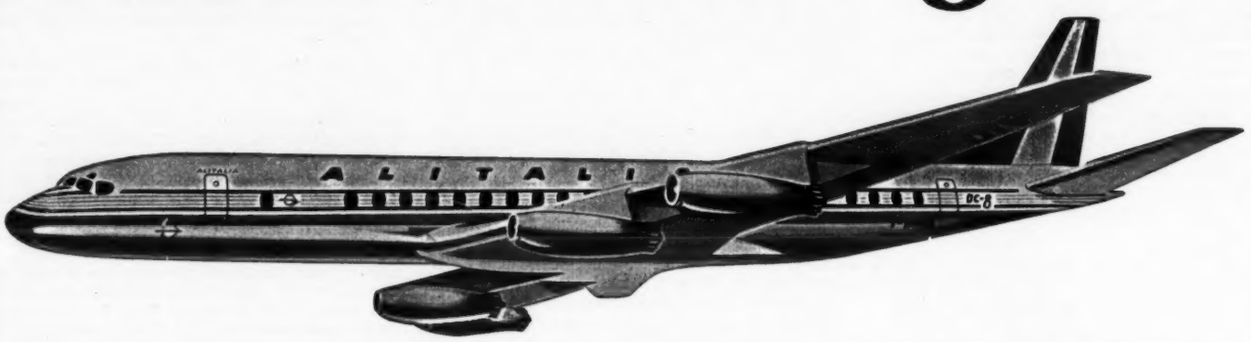

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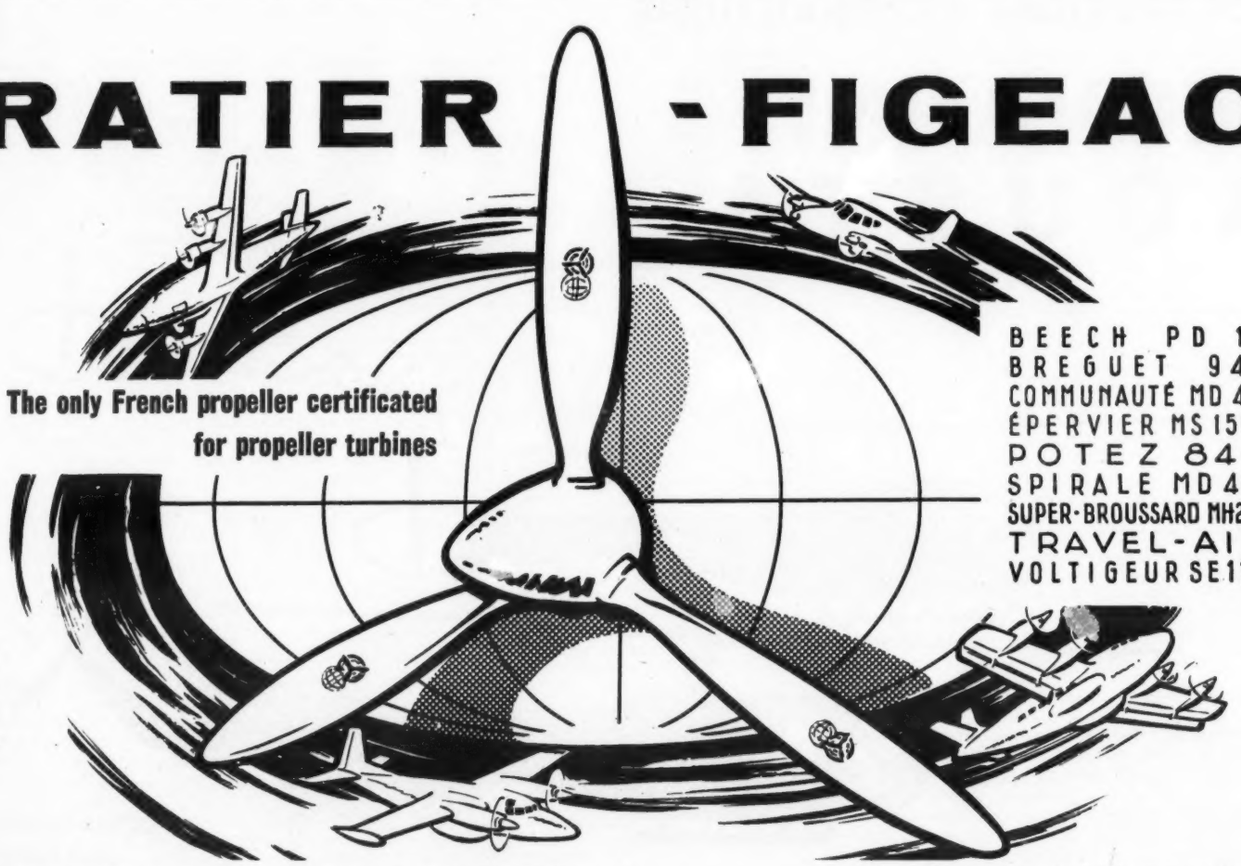

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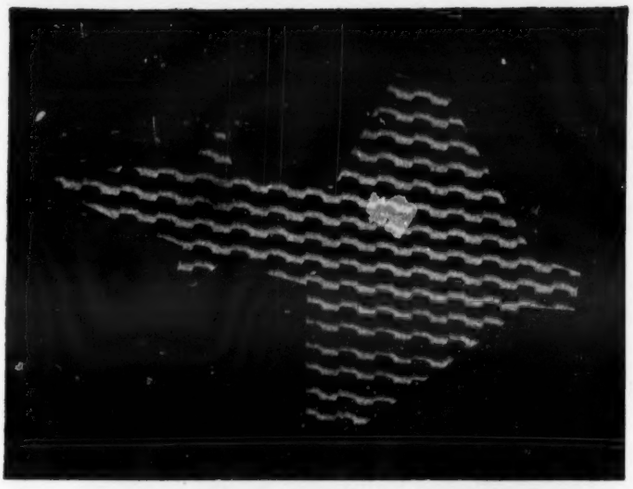

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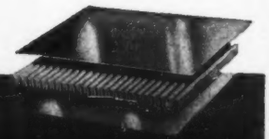

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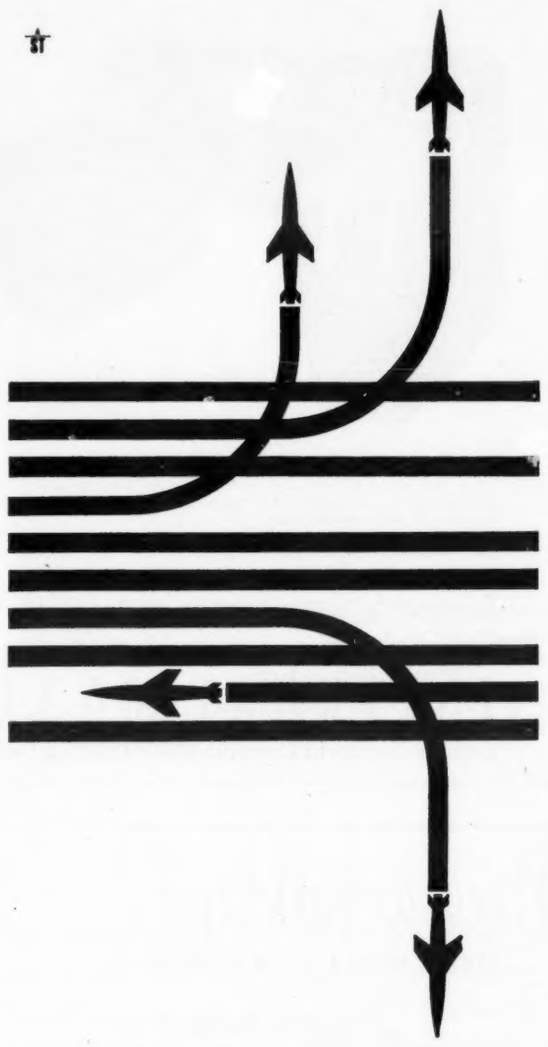

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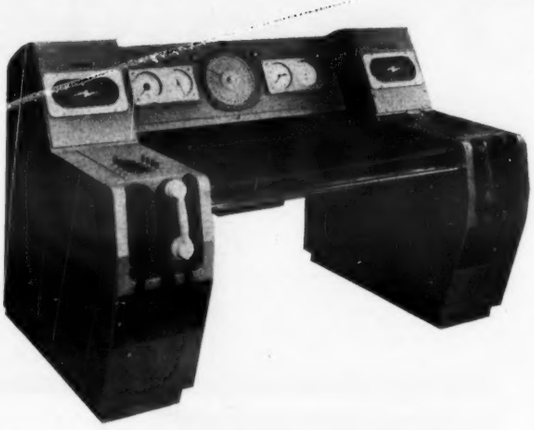

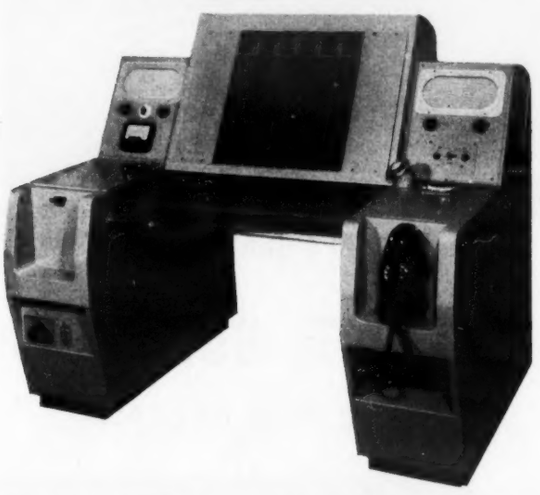

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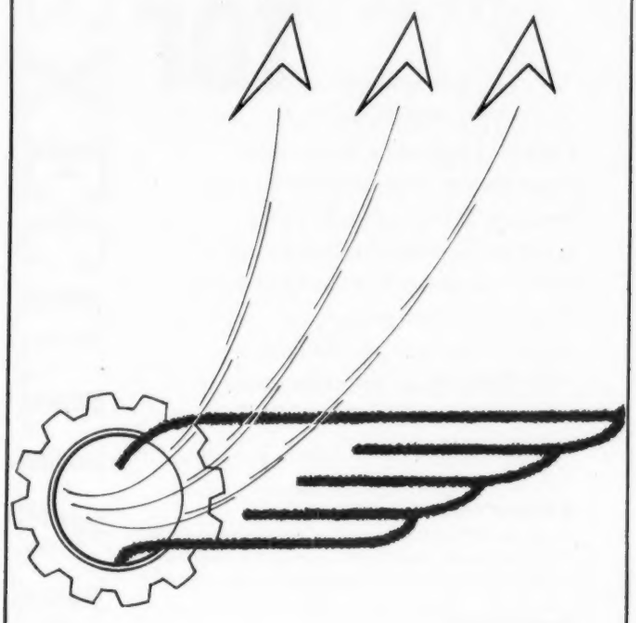

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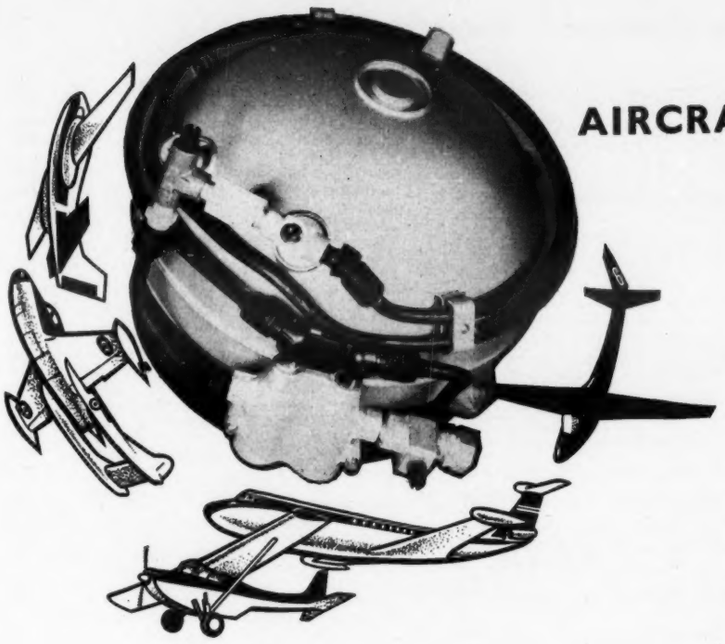

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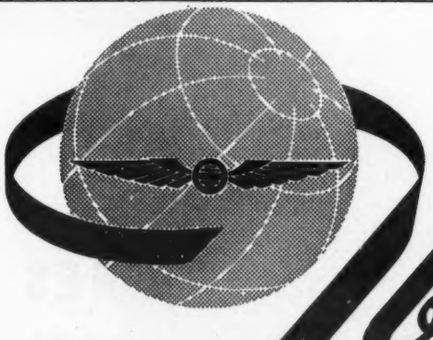

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